THE FATE OF UTAH'S SNOW IN A WARMING CLIMATE

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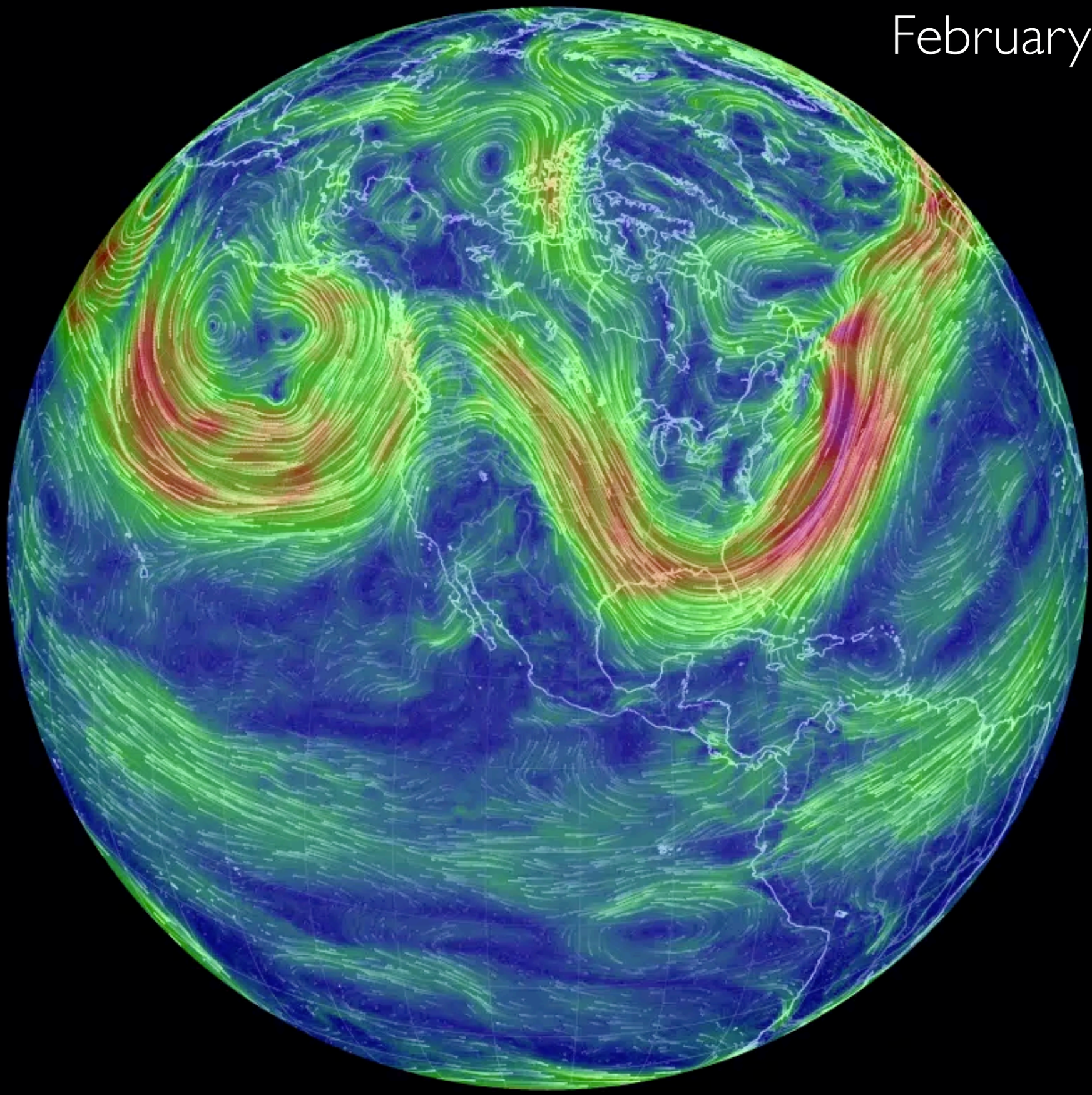
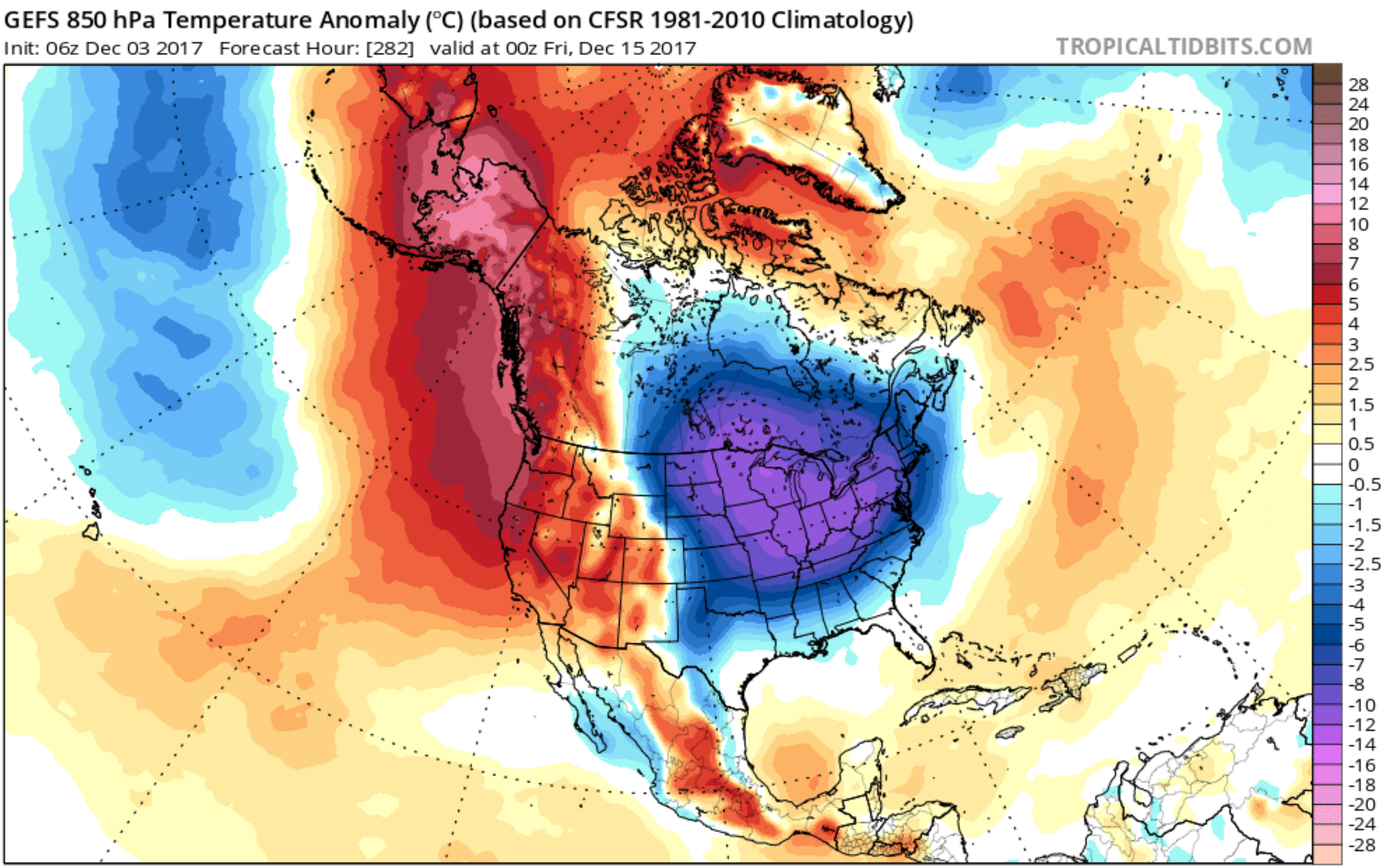
Quasi Stationary High Amplitude Atmospheric Wave Pattern (High Pressure Ridging)

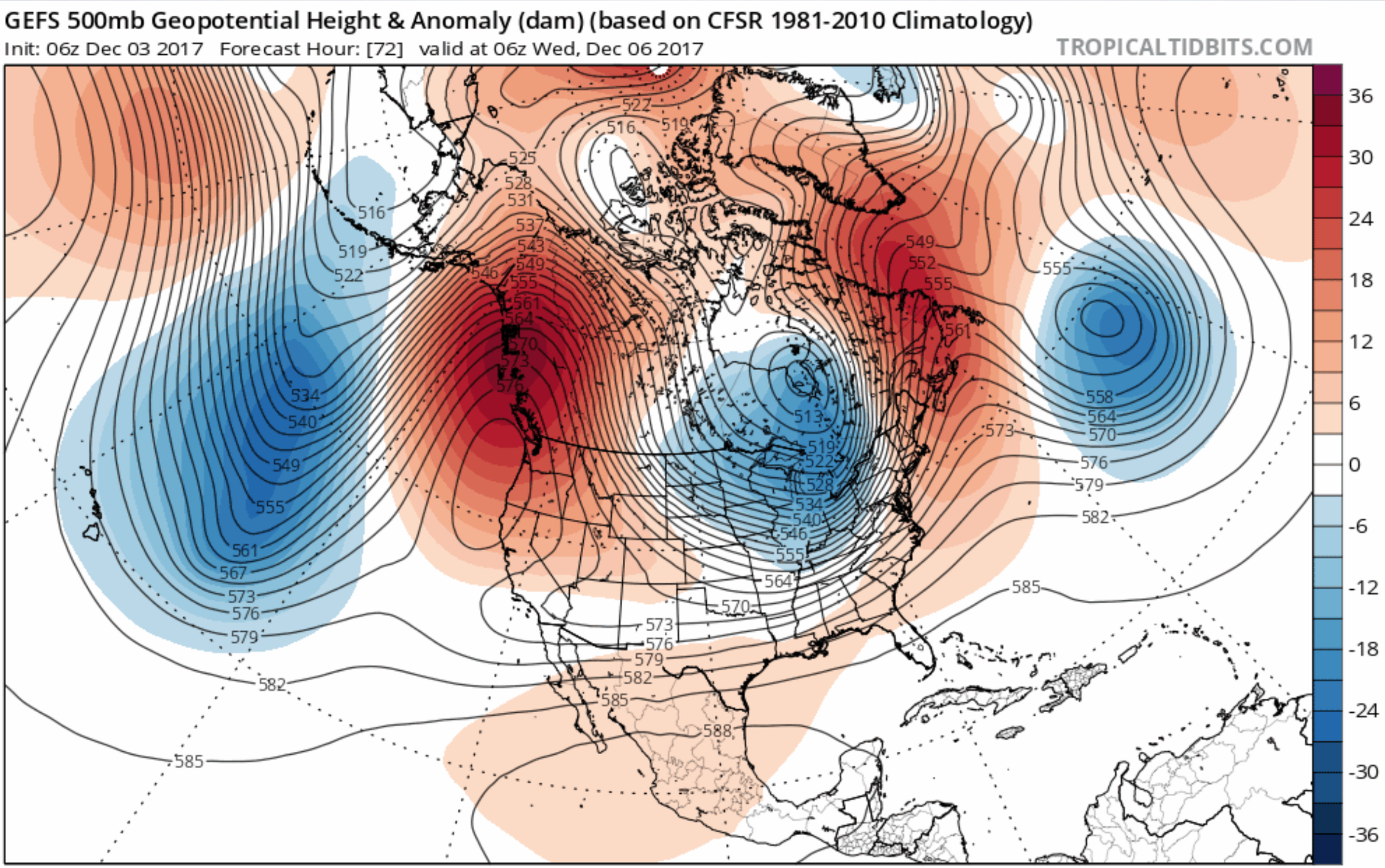
February 10th, 2016



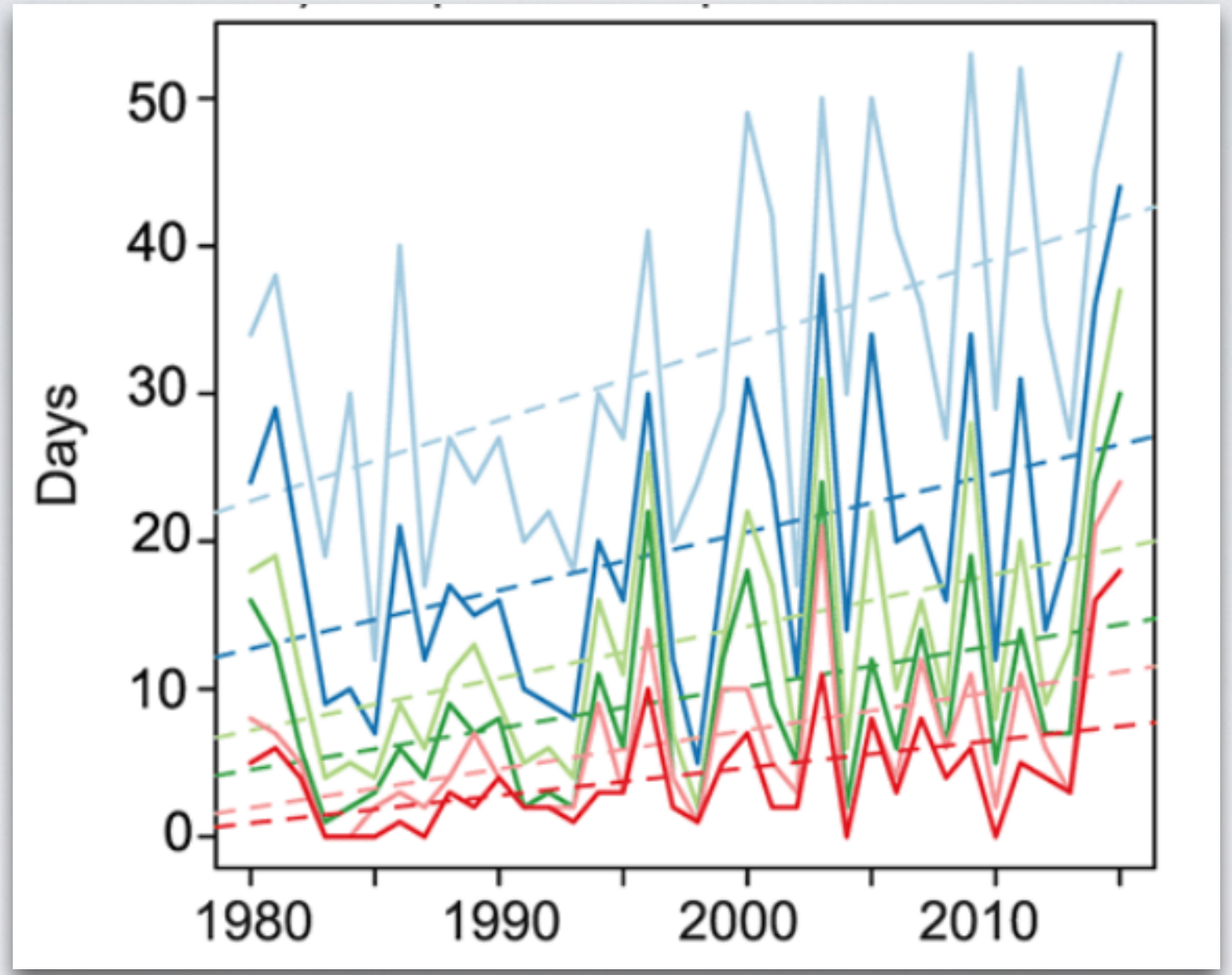
Surface Temperature Anomaly

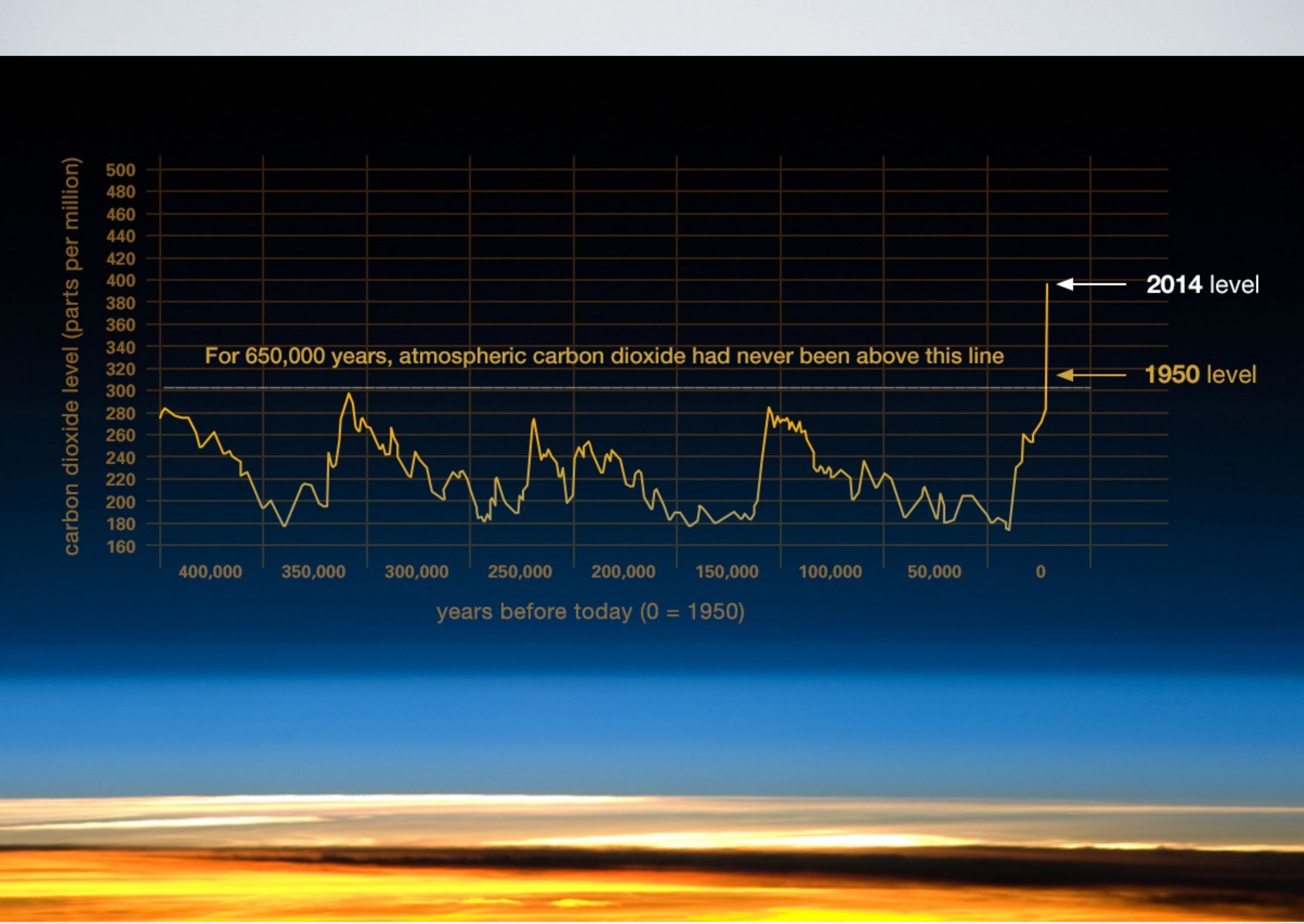


DiPole Weather Connection

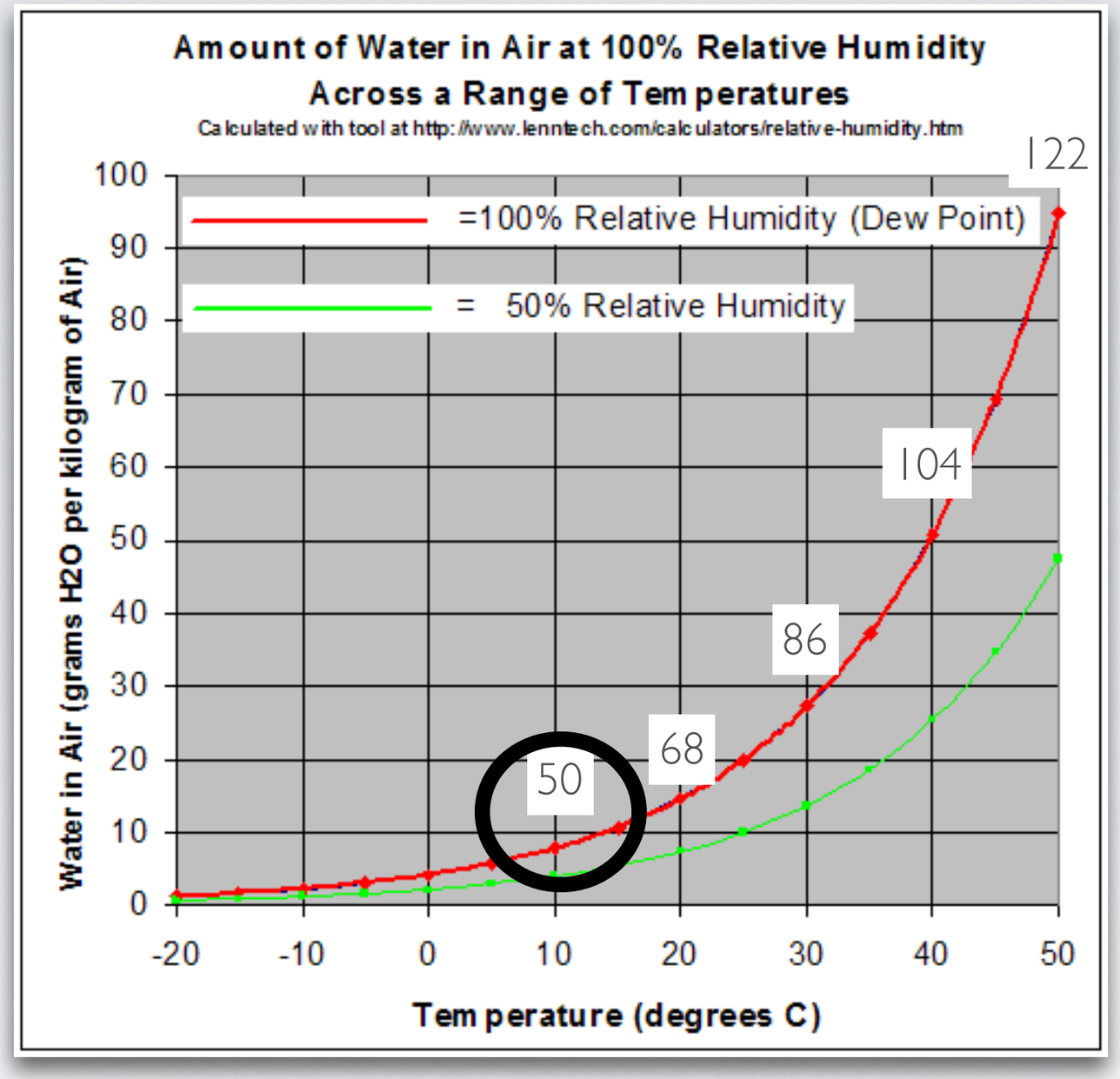


Frequency of Dipole Weather Pattern



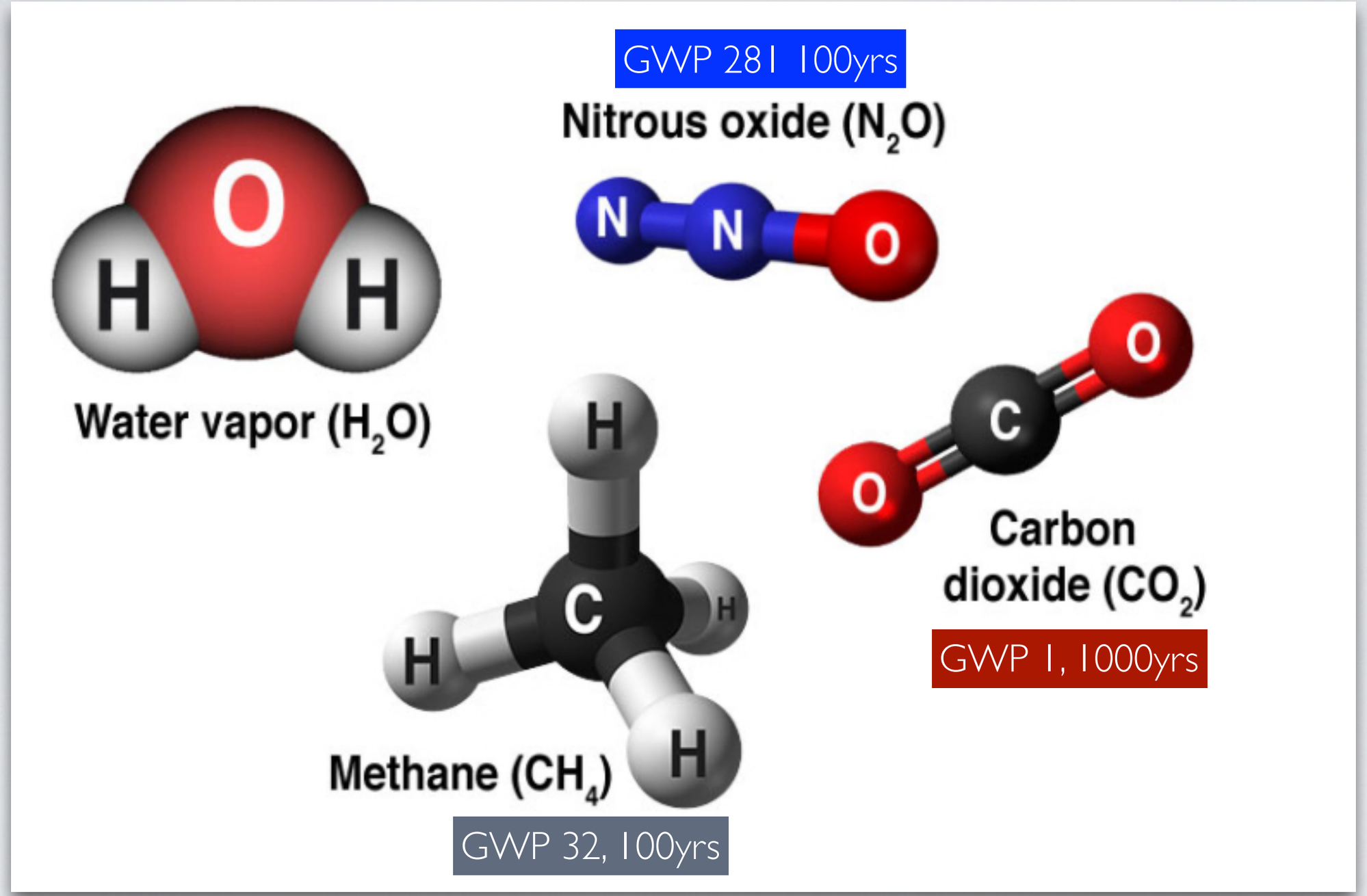

carbon dioxide level (parts per million)
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
For 650,000 years, atmospheric carbon dioxide had never been above this line
2014 level
1950 level
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
years before today (0 = 1950)

Changes in Atmospheric Moisture



7 % Increase Per Degree C of Warming

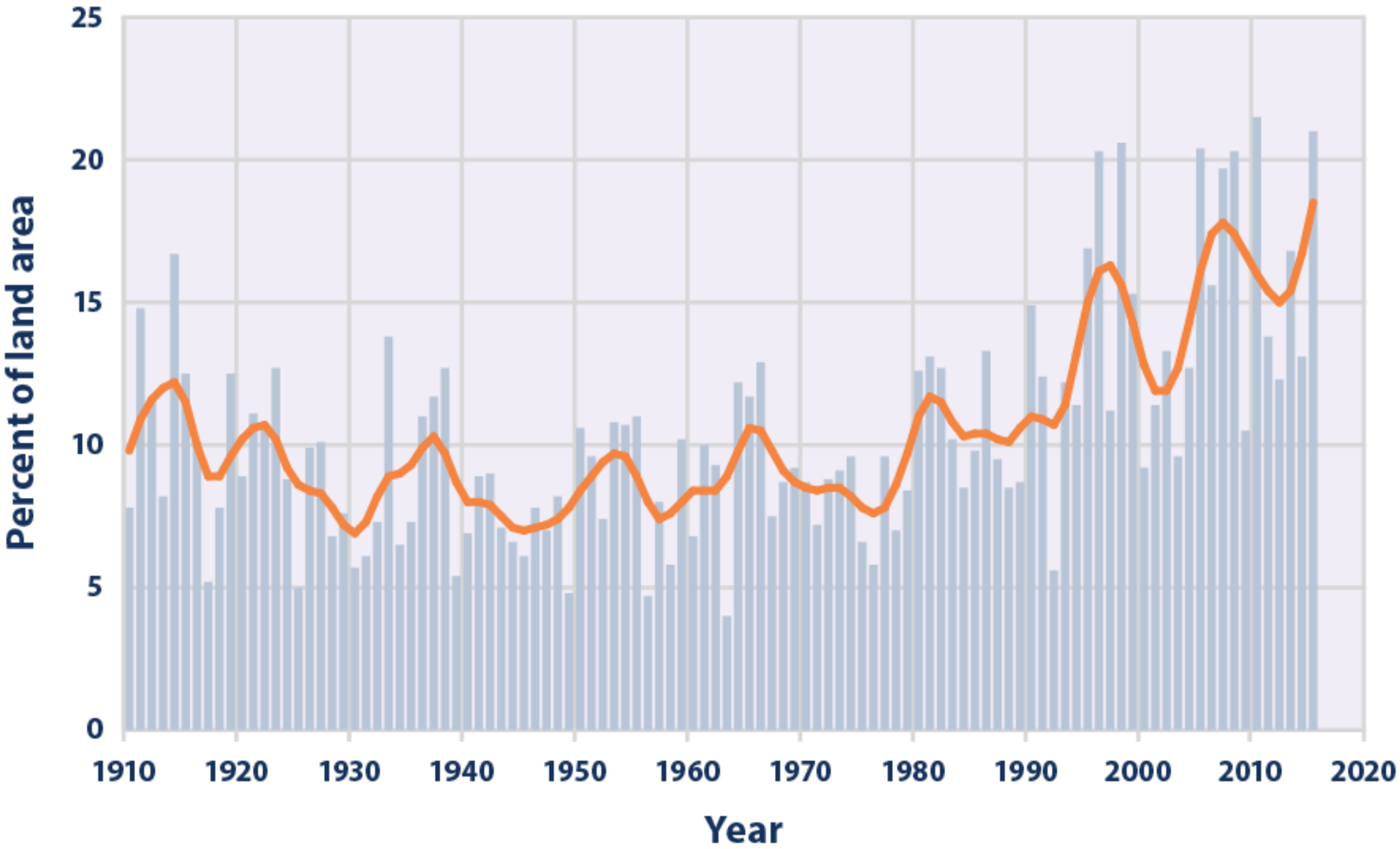
Molecular bonds of Climate Change Gases



GWP = Global Warming Potential

Warmer Air Can Hold More Water

Intense Rainfall Activity

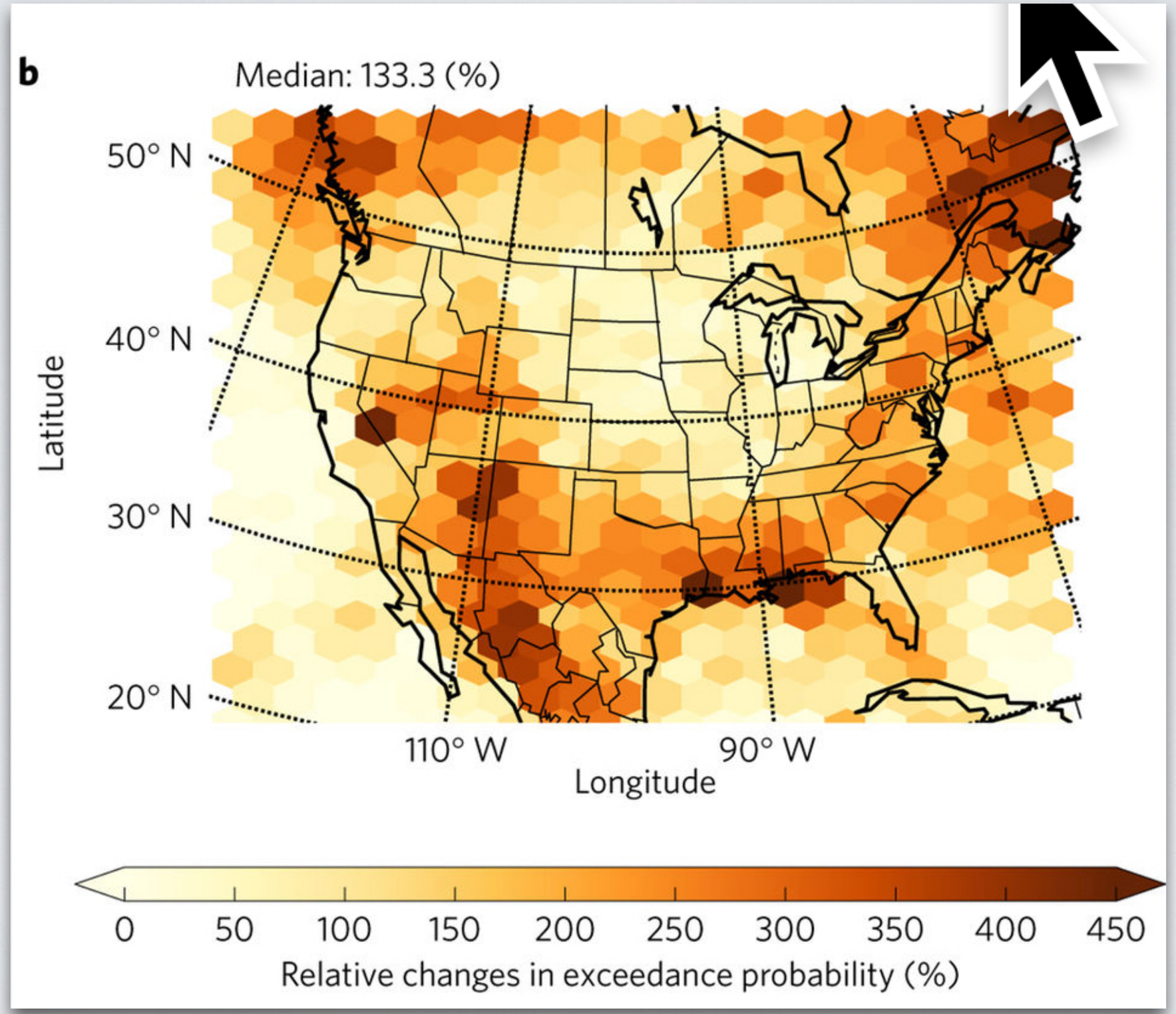


Data source: NOAA (National Oceanic and Atmospheric Administration). 2016. U.S. Climate Extremes Index. Accessed January 2016. www.ncdc.noaa.gov/extremes/cei.

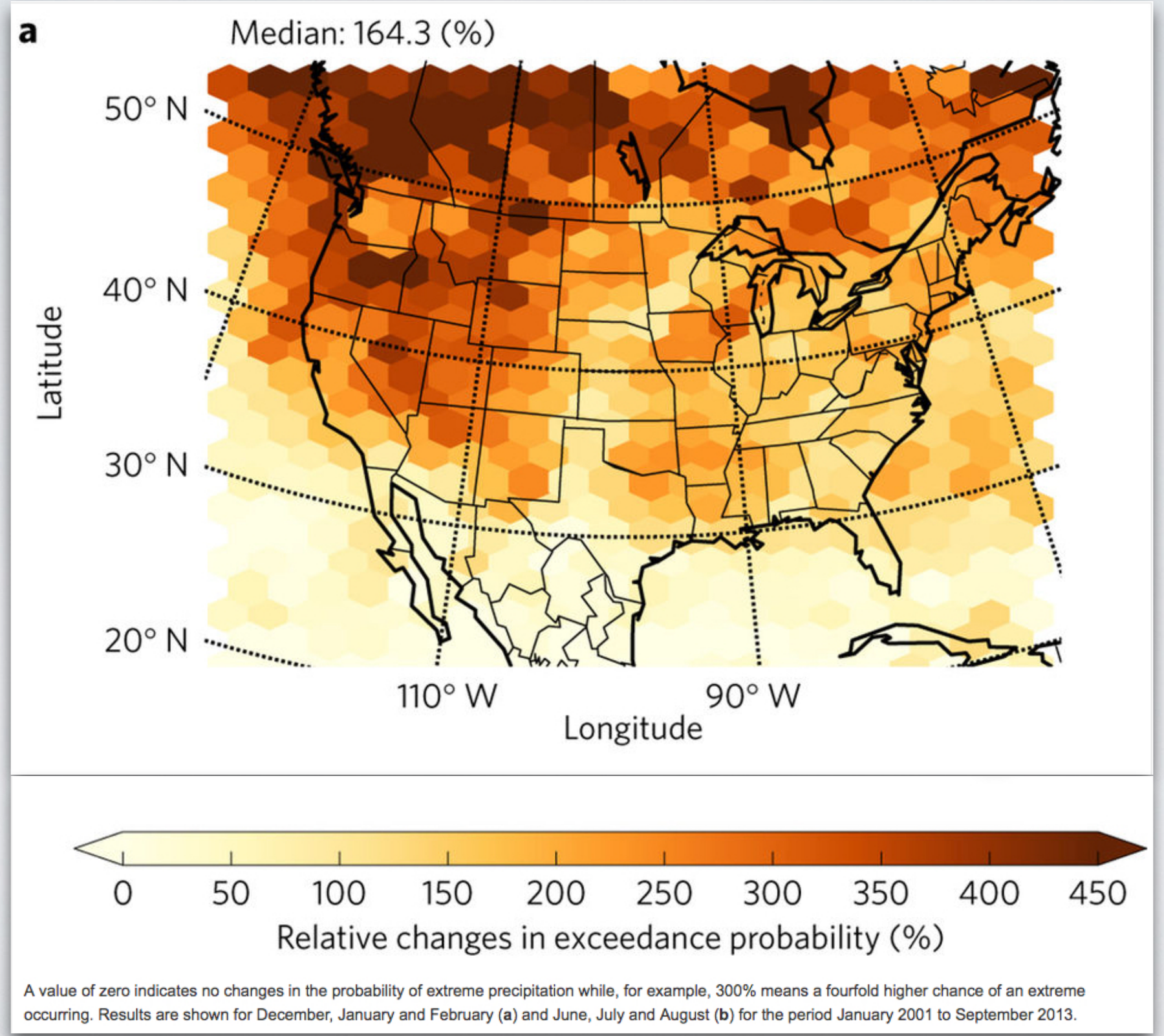
For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Relative Changes in Exceedance Probability With A Warming Climate

June - July - August



Relative Changes in Exceedance Probability With A Warming Climate
Dec. - Jan. - Feb



A value of zero indicates no changes in the probability of extreme precipitation while, for example, 300% means a fourfold higher chance of an extreme occurring. Results are shown for December, January and February (**a**) and June, July and August (**b**) for the period January 2001 to September 2013.

18% to 31% reduction in snow producing storms

Atmospheric Rivers

Meteorologic Winter

The science behind atmospheric rivers

An atmospheric river (AR) is a flowing column of condensed water vapor in the atmosphere responsible for producing significant levels of rain and snow, especially in the Western United States. When ARs move inland and sweep over the mountains, the water vapor rises and cools to create heavy precipitation. Though many ARs are weak systems that simply provide beneficial rain or snow, some of the larger, more powerful ARs can create extreme rainfall and floods capable of disrupting travel, inducing mudslides and causing catastrophic damage to life and property. Visit www.research.noaa.gov to learn more.

A strong AR transports an amount of water vapor roughly equivalent to 7.5–15 times the average flow of water at the mouth of the Mississippi River.

ARs are a primary feature in the entire global water cycle and are tied closely to both water supply and flood risks, particularly in the Western U.S.

On average, about 30-50% of annual precipitation on the West Coast occurs in just a few AR events and contributes to the water supply — and flooding risk.

ARs move with the weather and are present somewhere on Earth at any given time.

ARs are approximately 250–375 miles wide on average.

Scientists' improved understanding of ARs has come from roughly a decade of scientific studies that use observations from satellites, radar and aircraft as well as the latest numerical weather models. More studies are underway, including a 2015 scientific mission that added data from instruments aboard a NOAA ship.

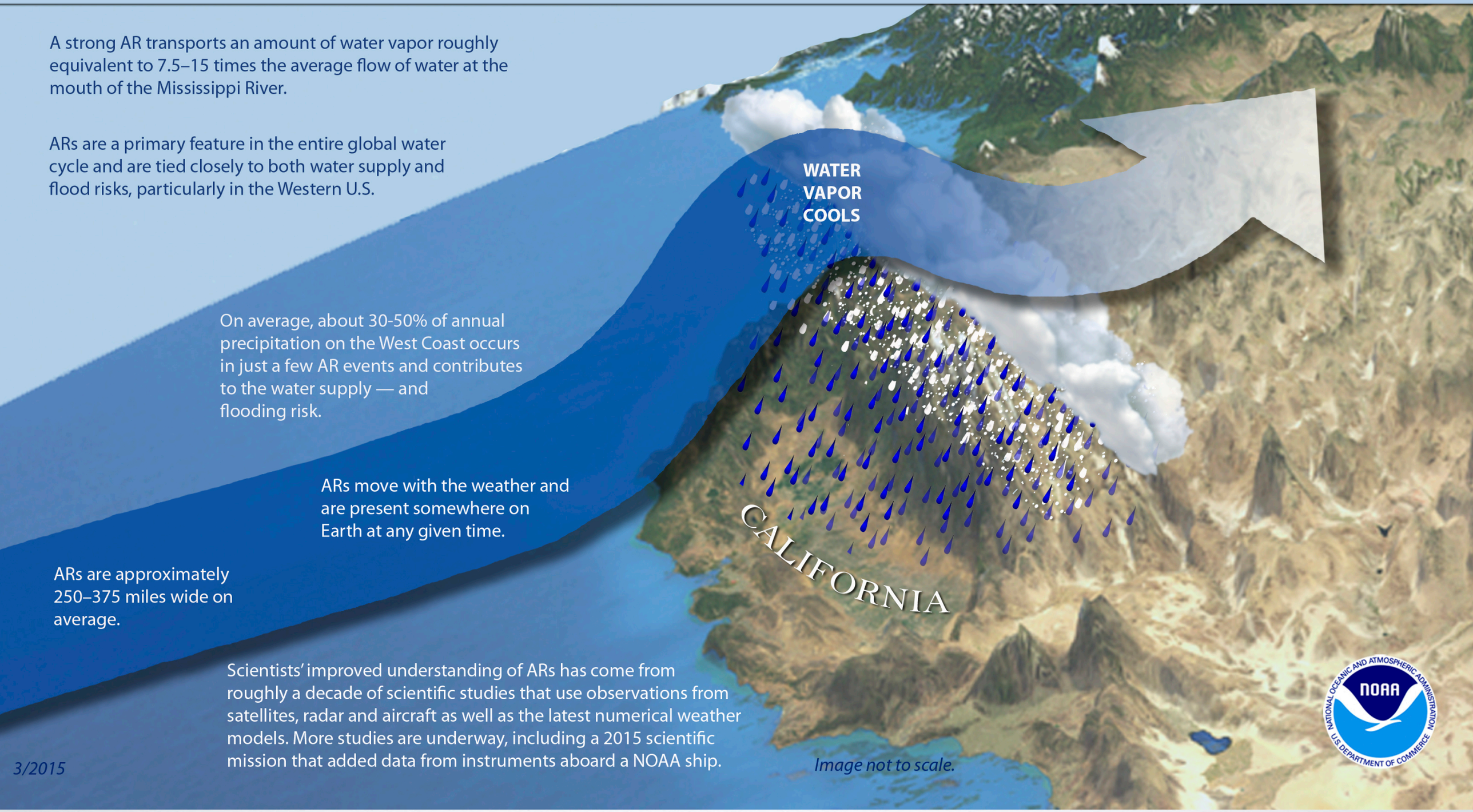
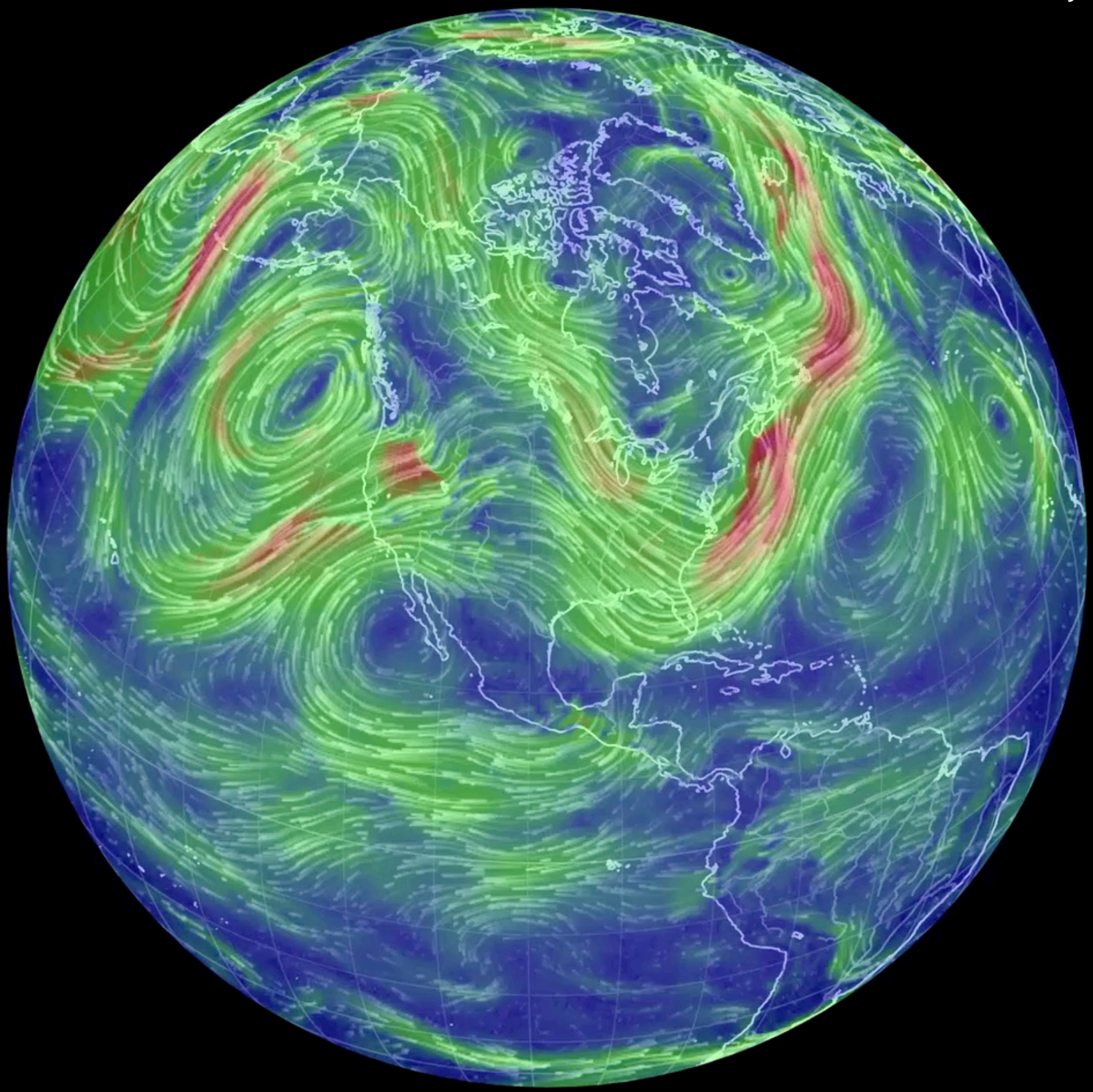


Image not to scale.

3/2015

January 7th, 2017



Oroville Dam Spillway Damage

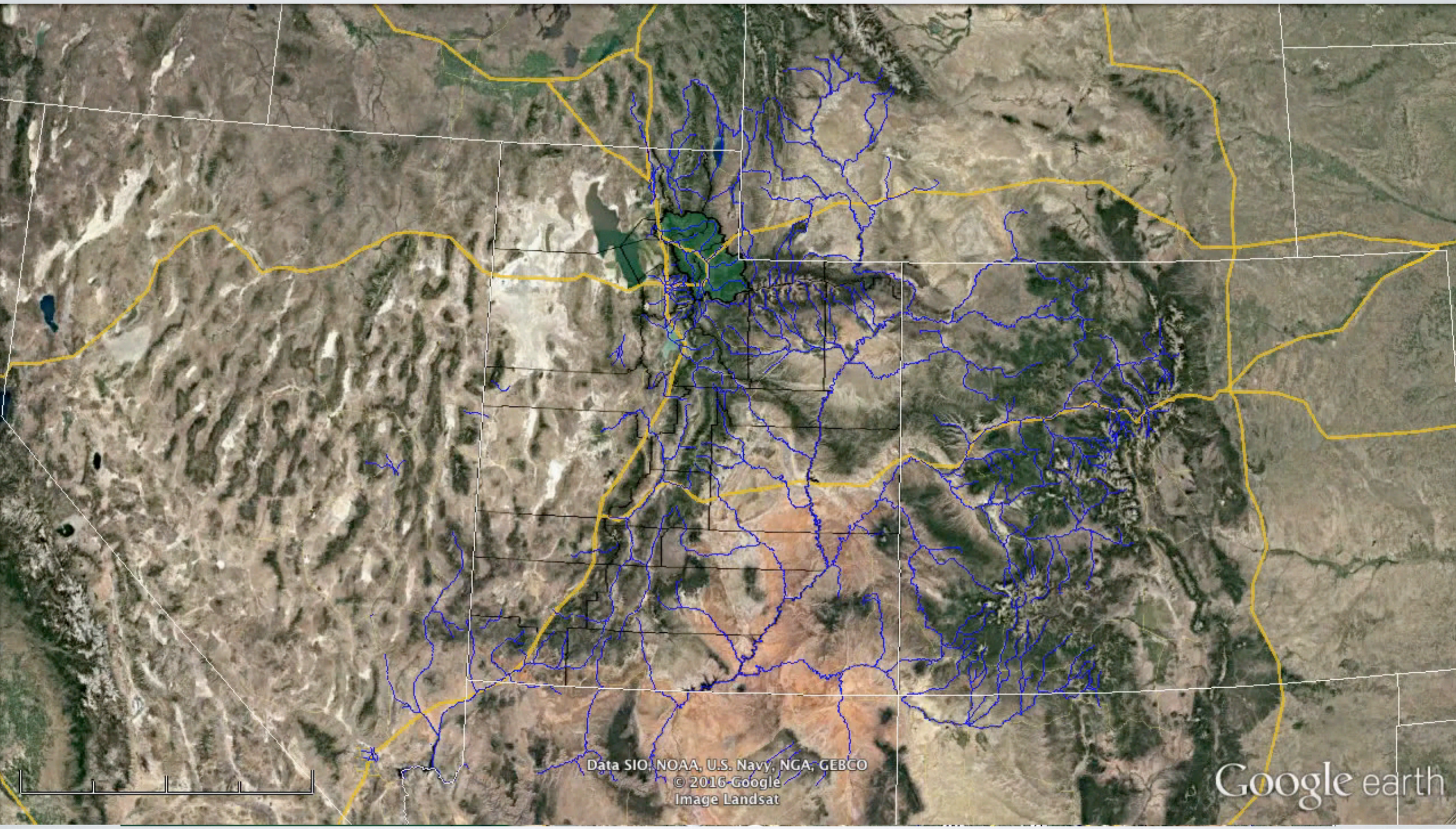
February 2017

Oroville Dam Spillway Damage

February 2017

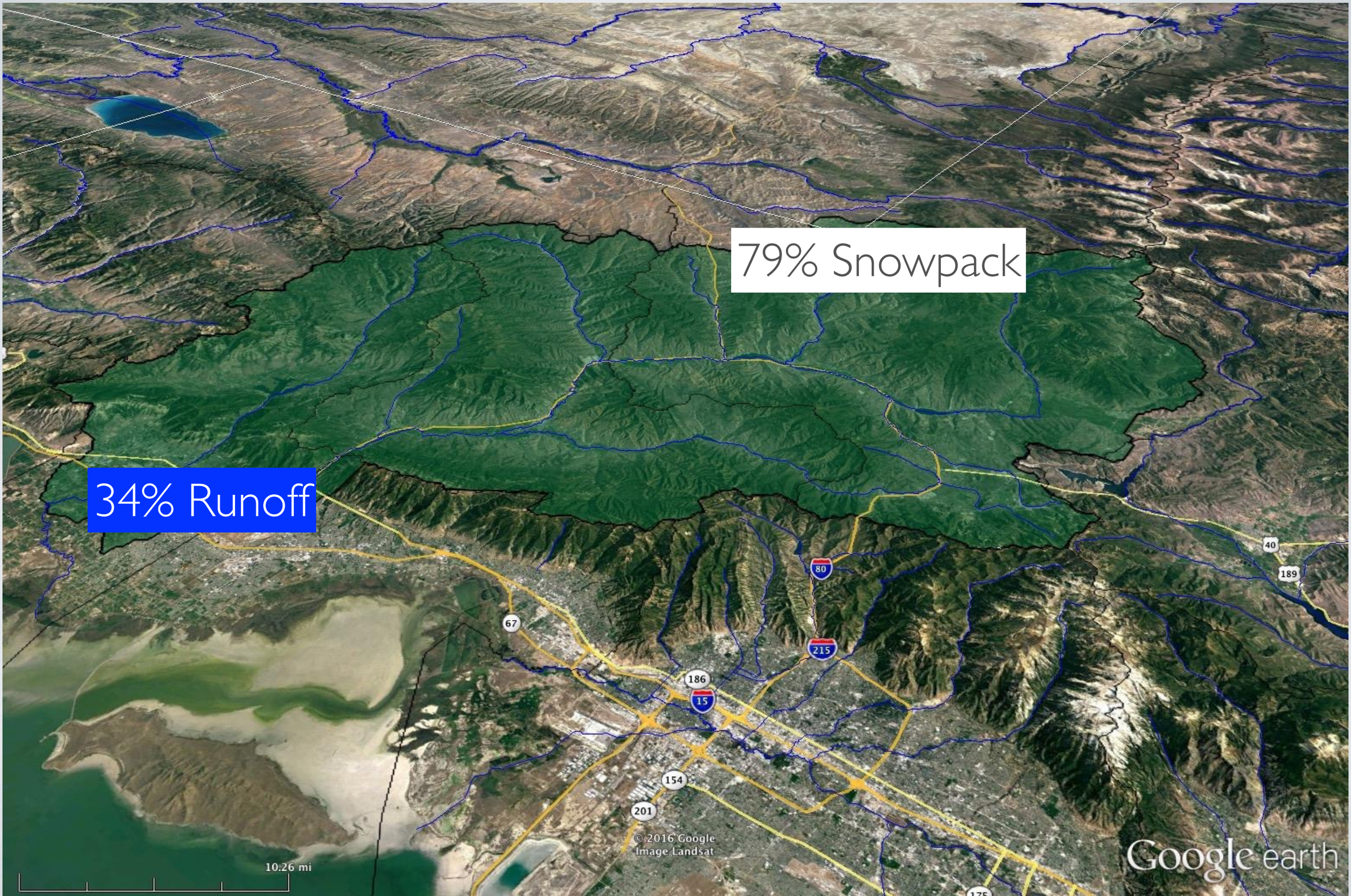
Changes in Snowmelt Timing and Onset

Weber River Drainage



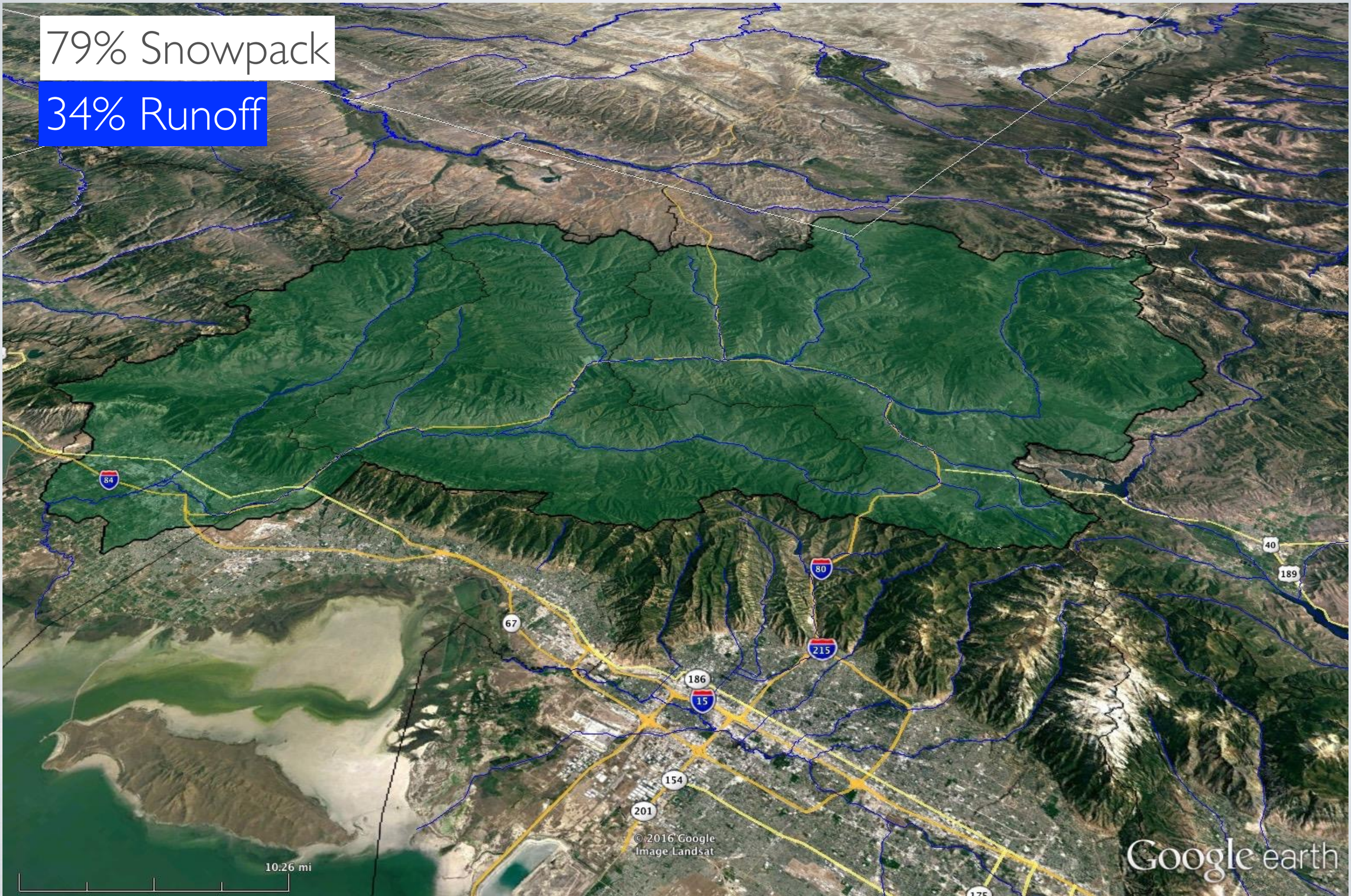
Weber River Drainage

2003 Water Year



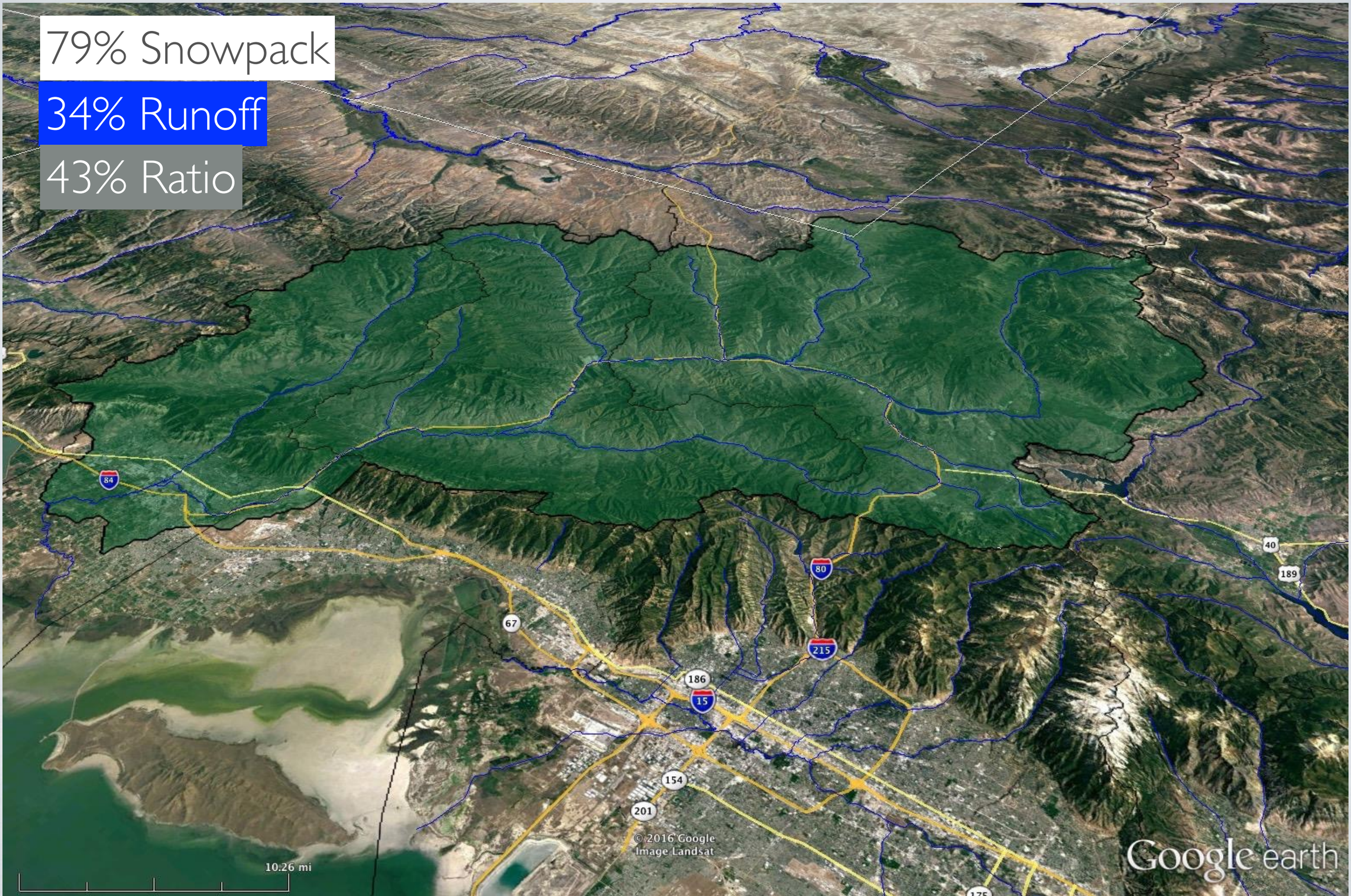
Weber River Drainage

2003 Water Year



Weber River Drainage

2003 Water Year

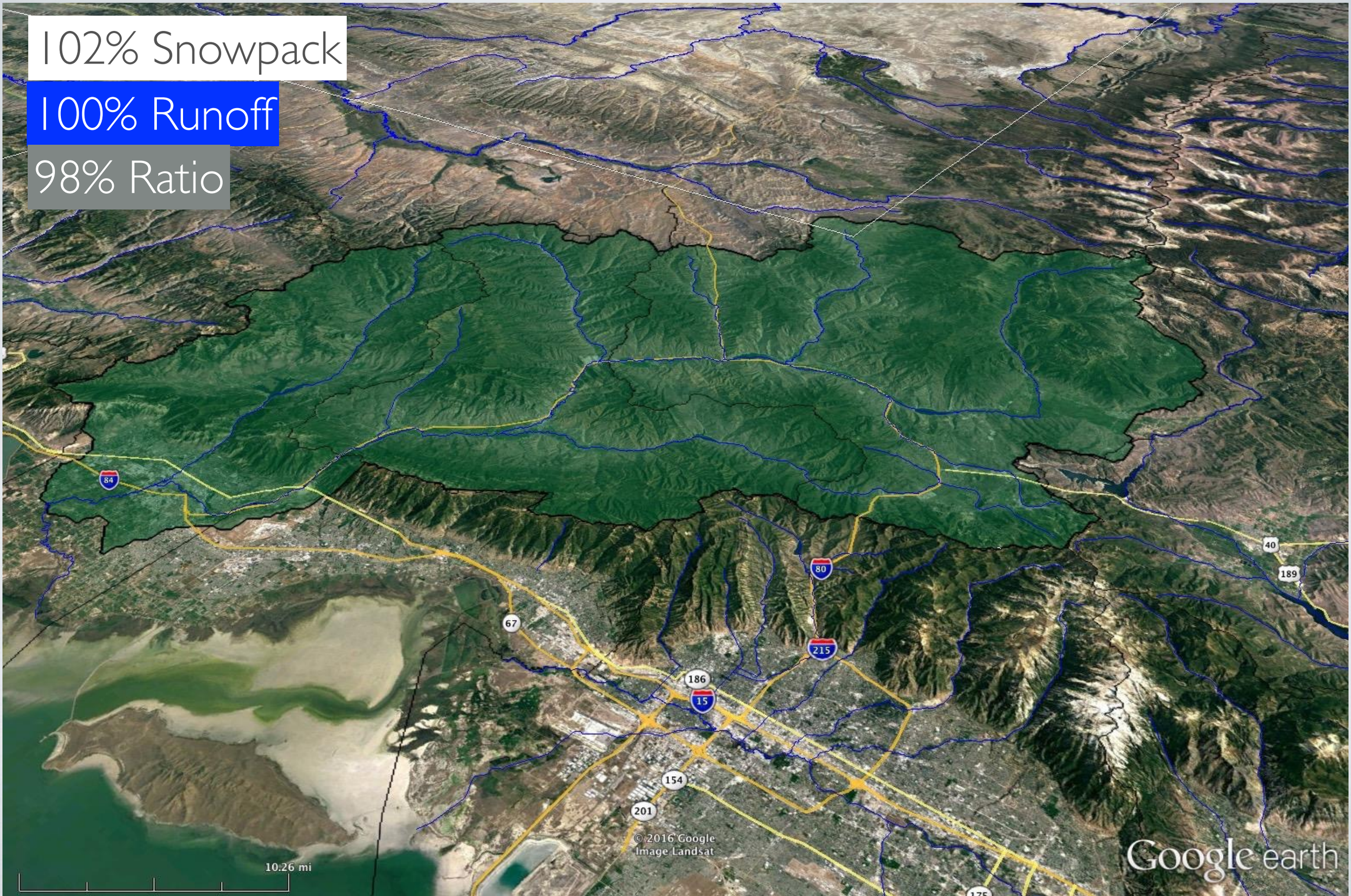


Weber River Drainage

2005 Water Year

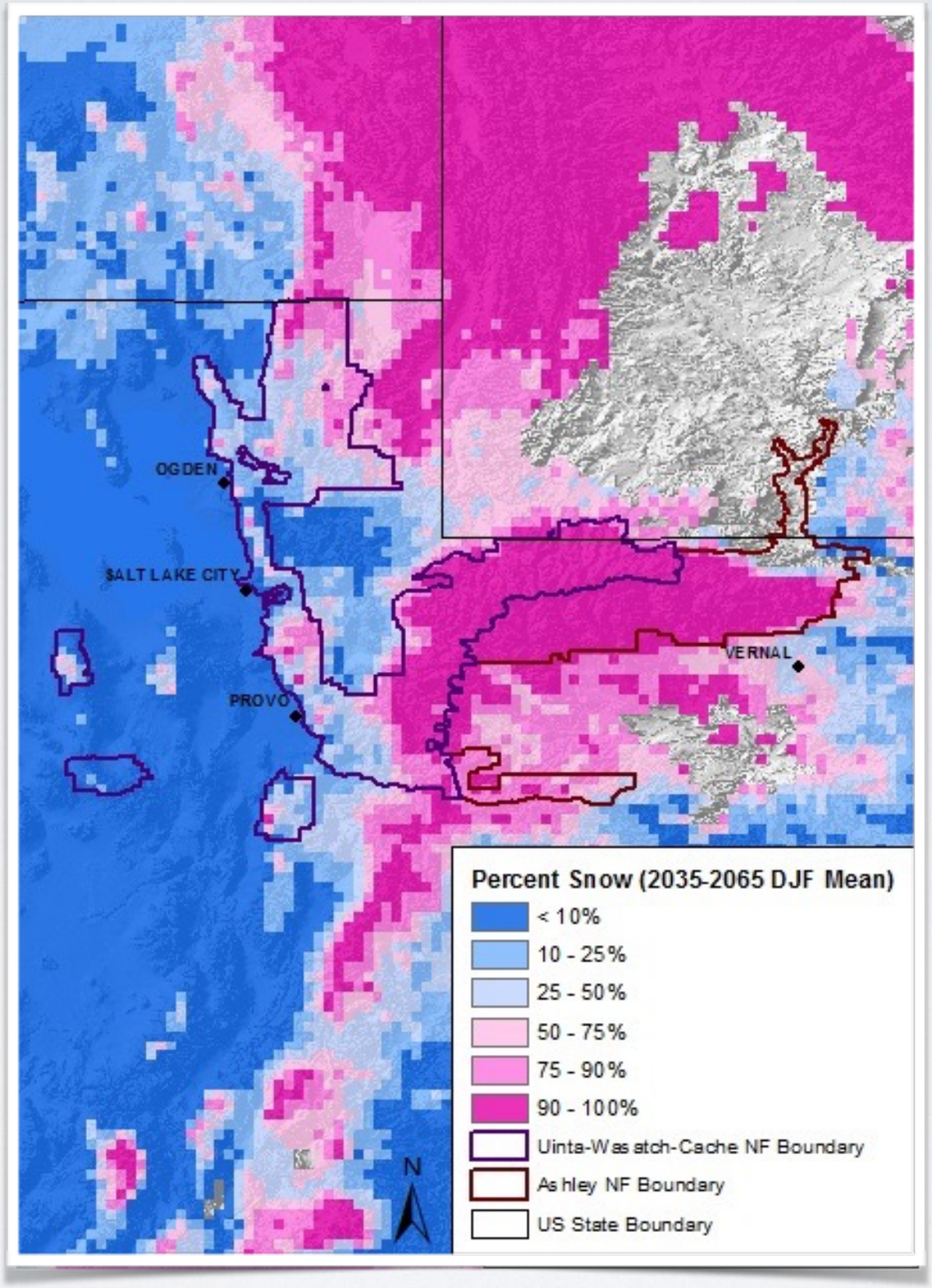
Weber River Drainage

2005 Water Year



Changes in Snow Coverage

CHANGE IN SNOW HYDROLOGY TO RAIN



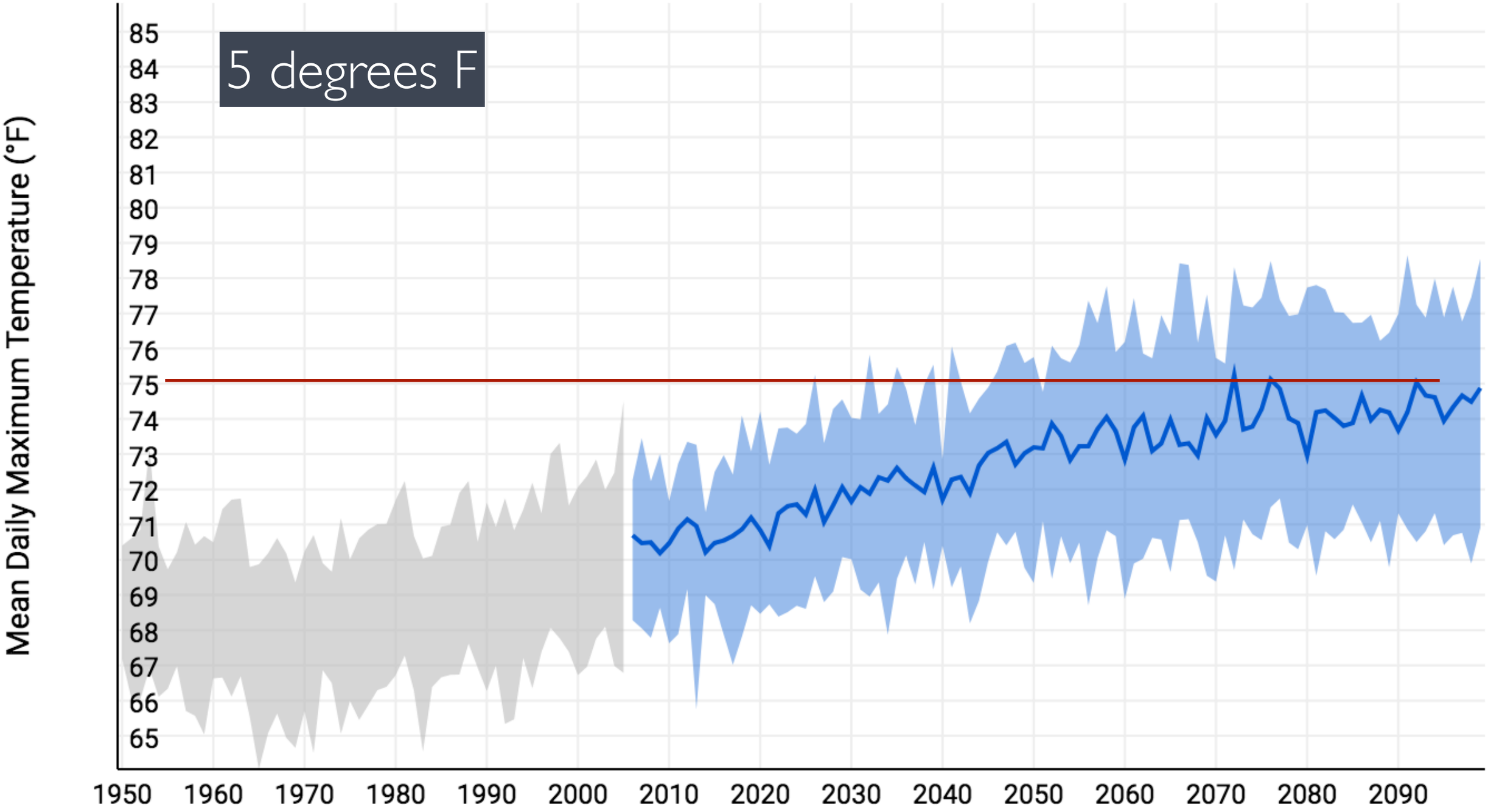
Rice, J.; Bardsley, T.; Joyce, L. A. [and others]. In review. Assessment of watershed vulnerability to climate change for the Uinta-Wasatch-Cache and Ashley National Forests.

How Hot Will It Get?

Salt Lake City Low/High Emissions Scenario
Projected Temperature Increase Due To Climate Change

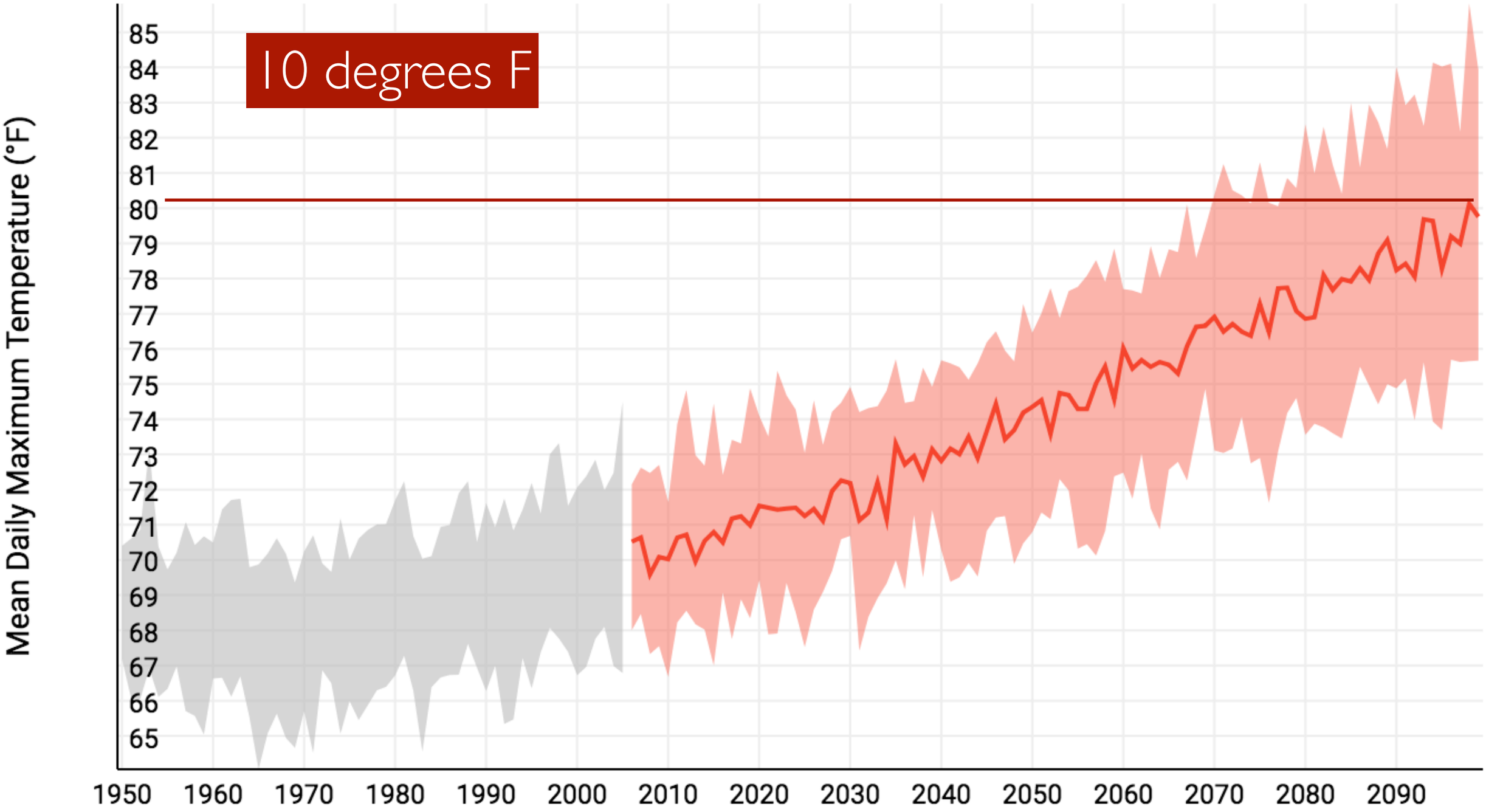
Washington County Low Emissions Scenario

Projected Temperature Increase Due To Climate Change



Washington County High Emissions Scenario

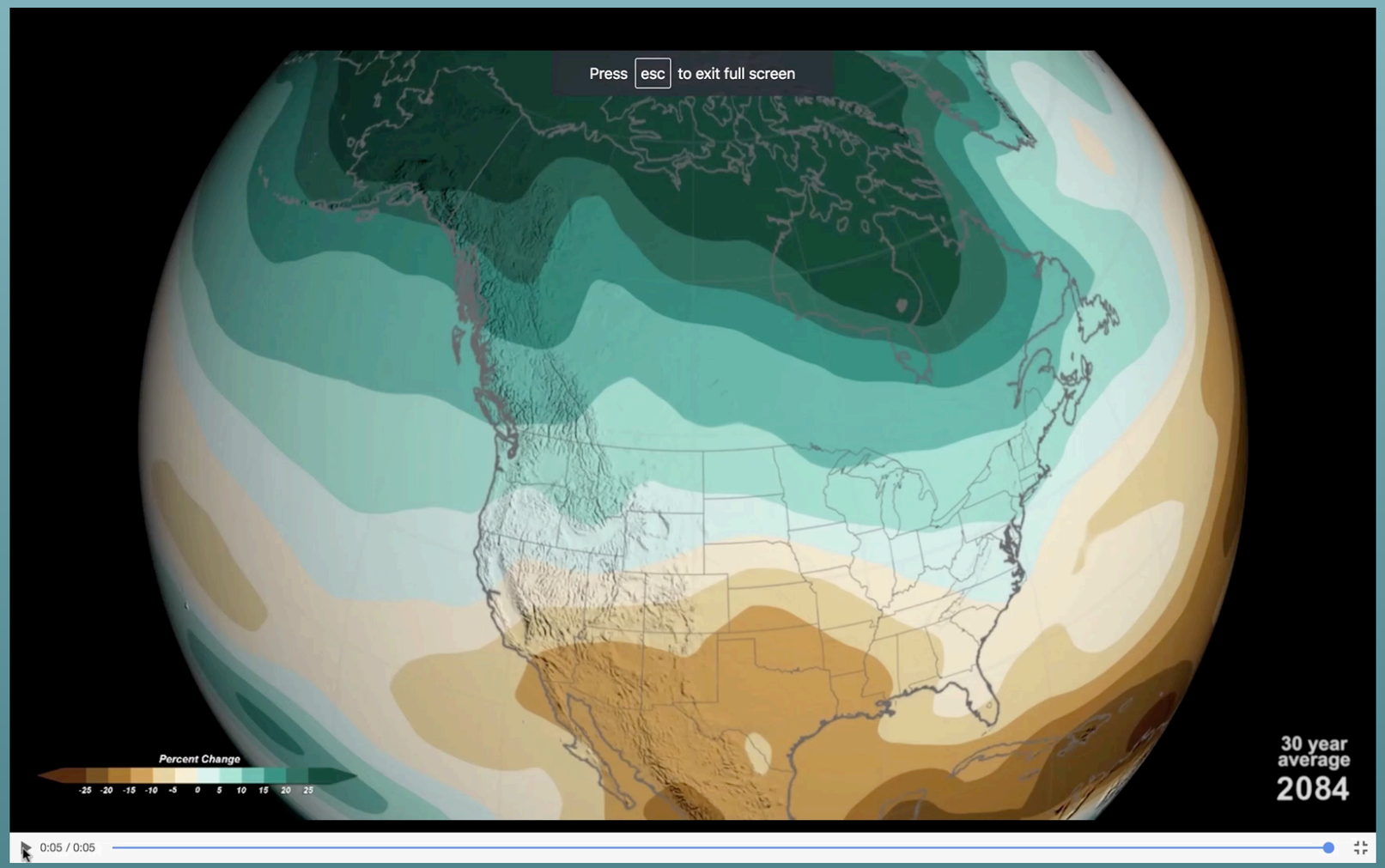
Projected Temperature Increase Due To Climate Change



Changes in Precipitation

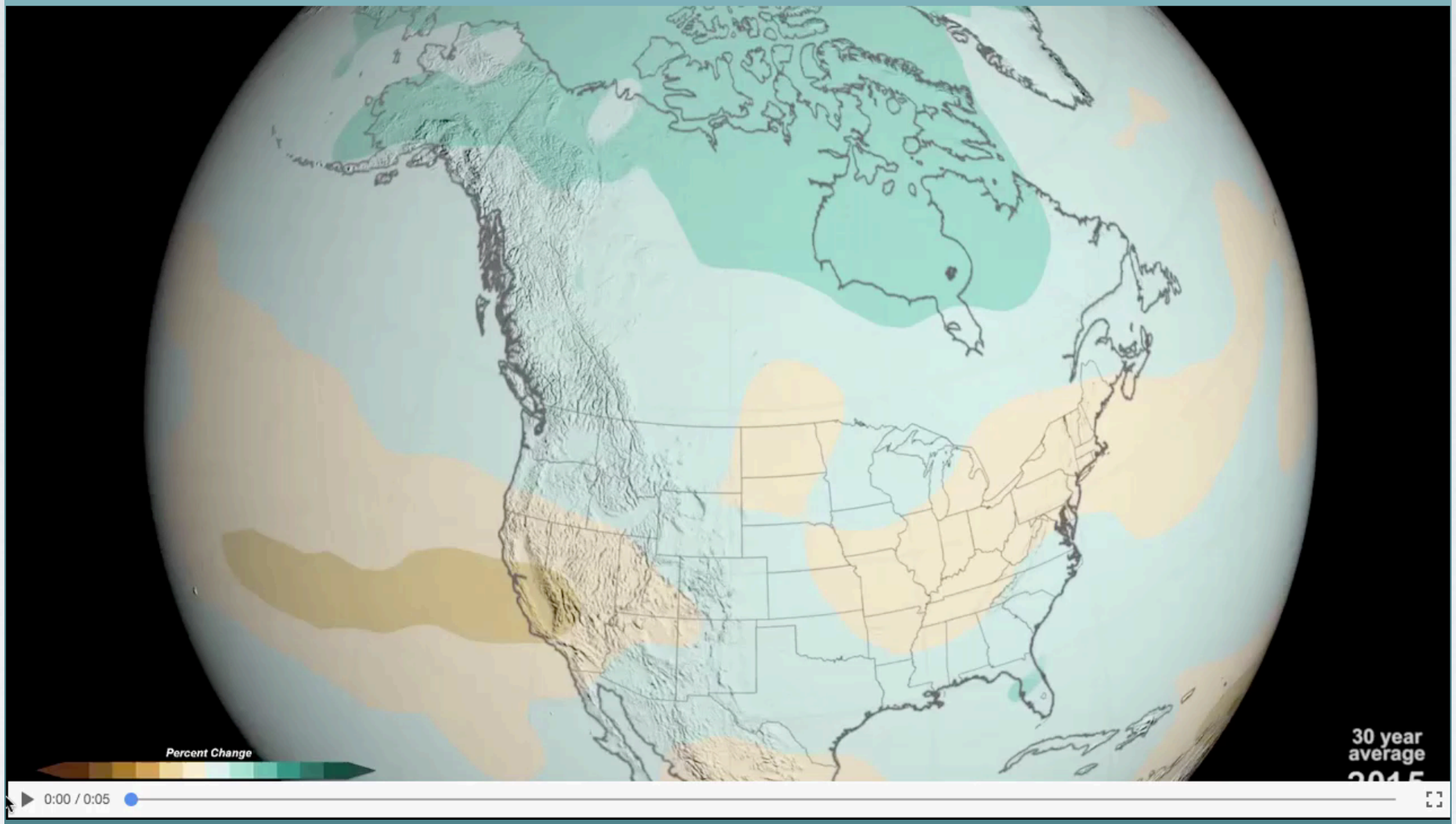
Precipitation Changes

NASA/Goddard Space Flight Center Annual Precipitation High Emissions



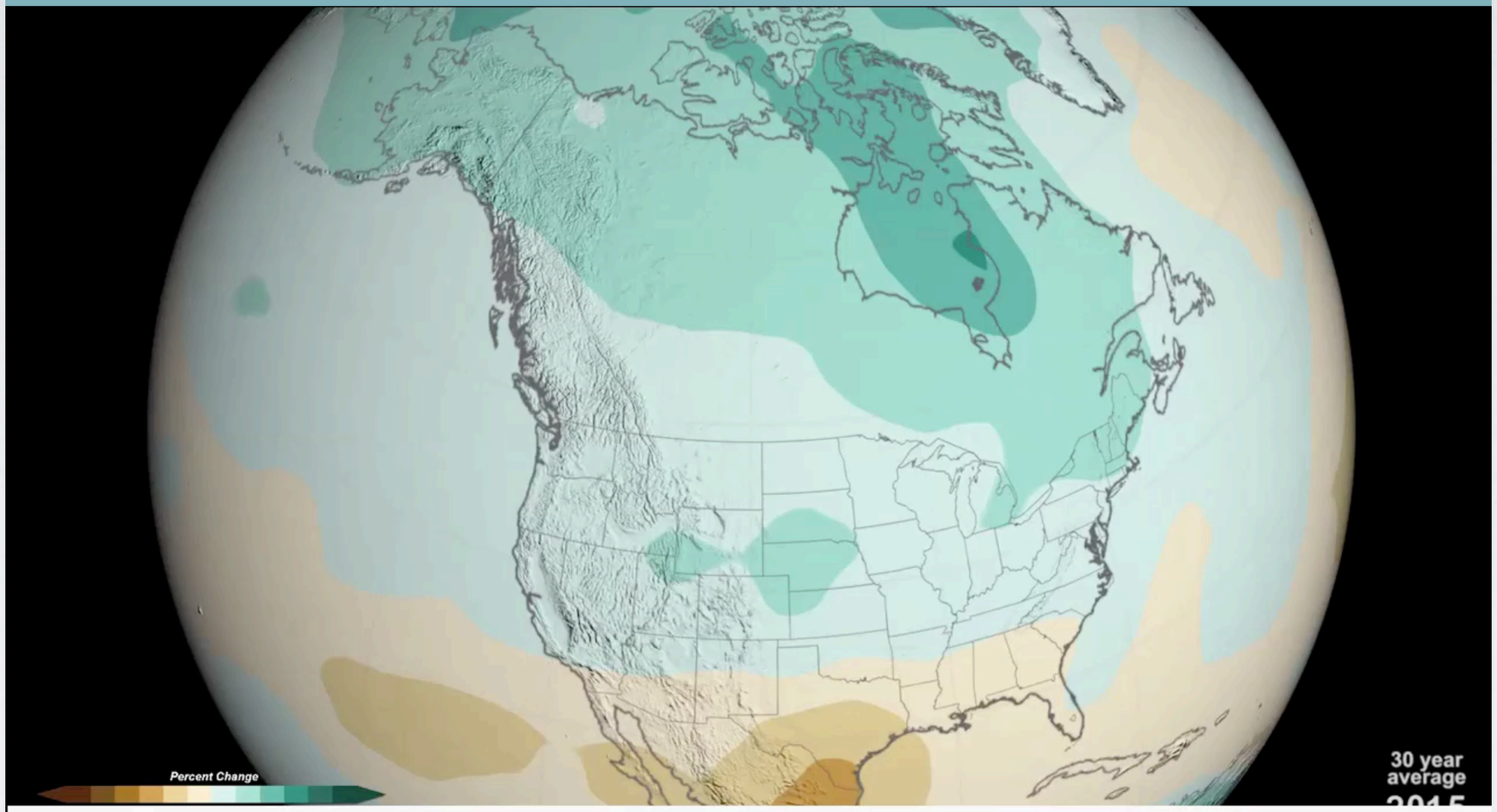
Precipitation Changes

NASA/Goddard Space Flight Center Fall Precipitation High Emissions



Precipitation Changes

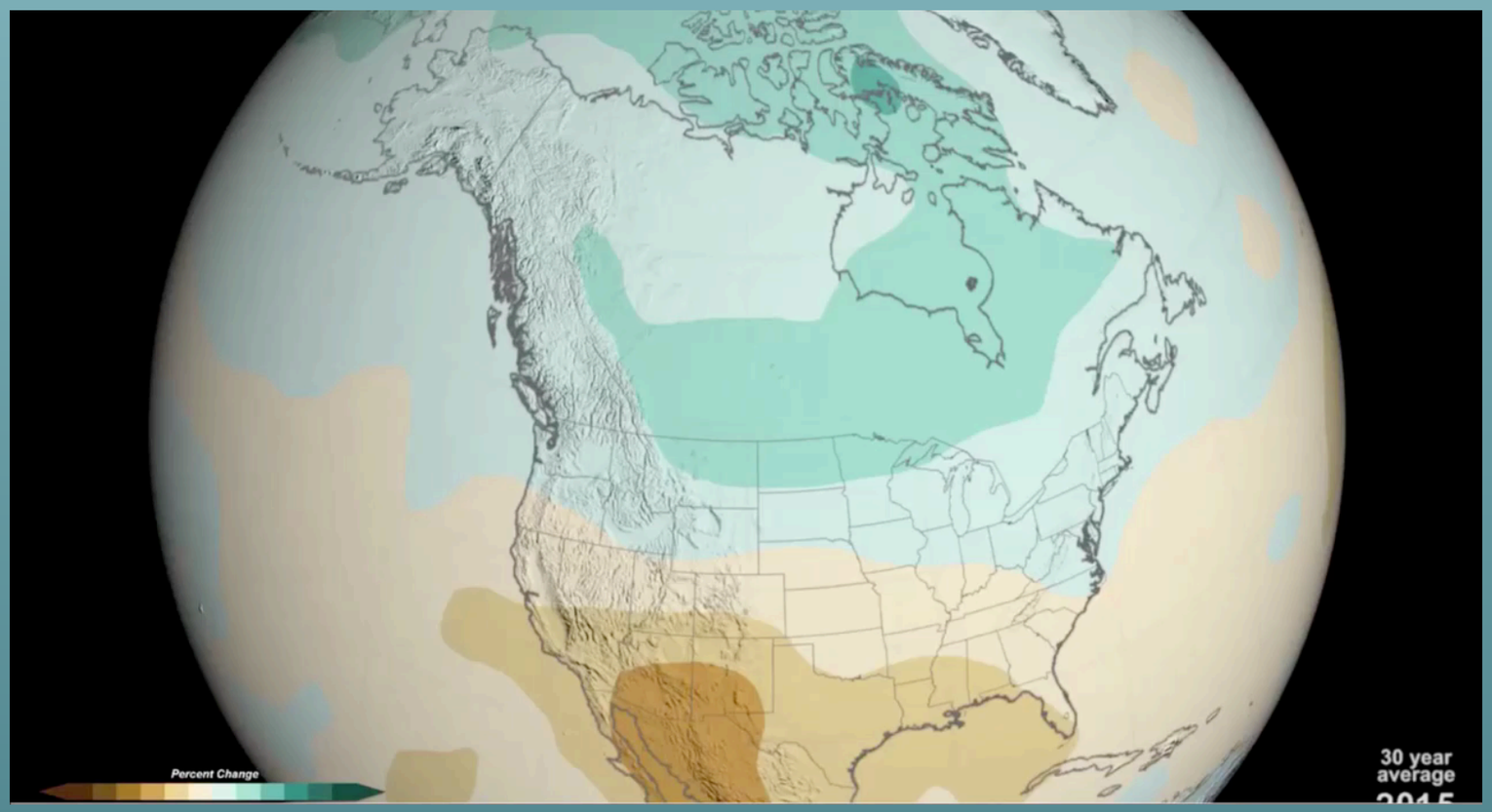
NASA/Goddard Space Flight Center Winter Precipitation High Emissions



0:00 / 0:05

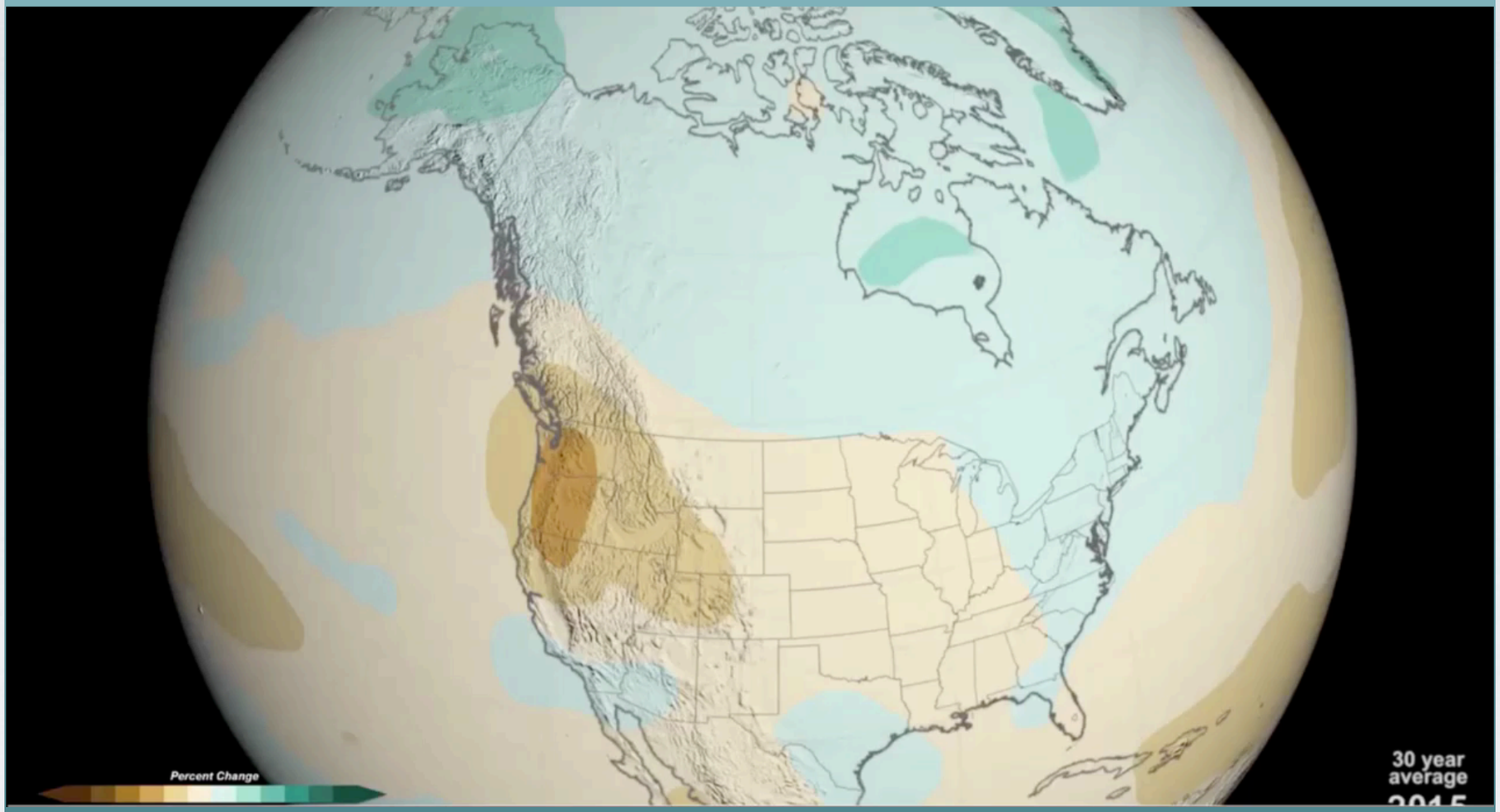
Precipitation Changes

NASA/Goddard Space Flight Center Spring Precipitation High Emissions



Precipitation Changes

NASA/Goddard Space Flight Center Summer Precipitation High Emissions

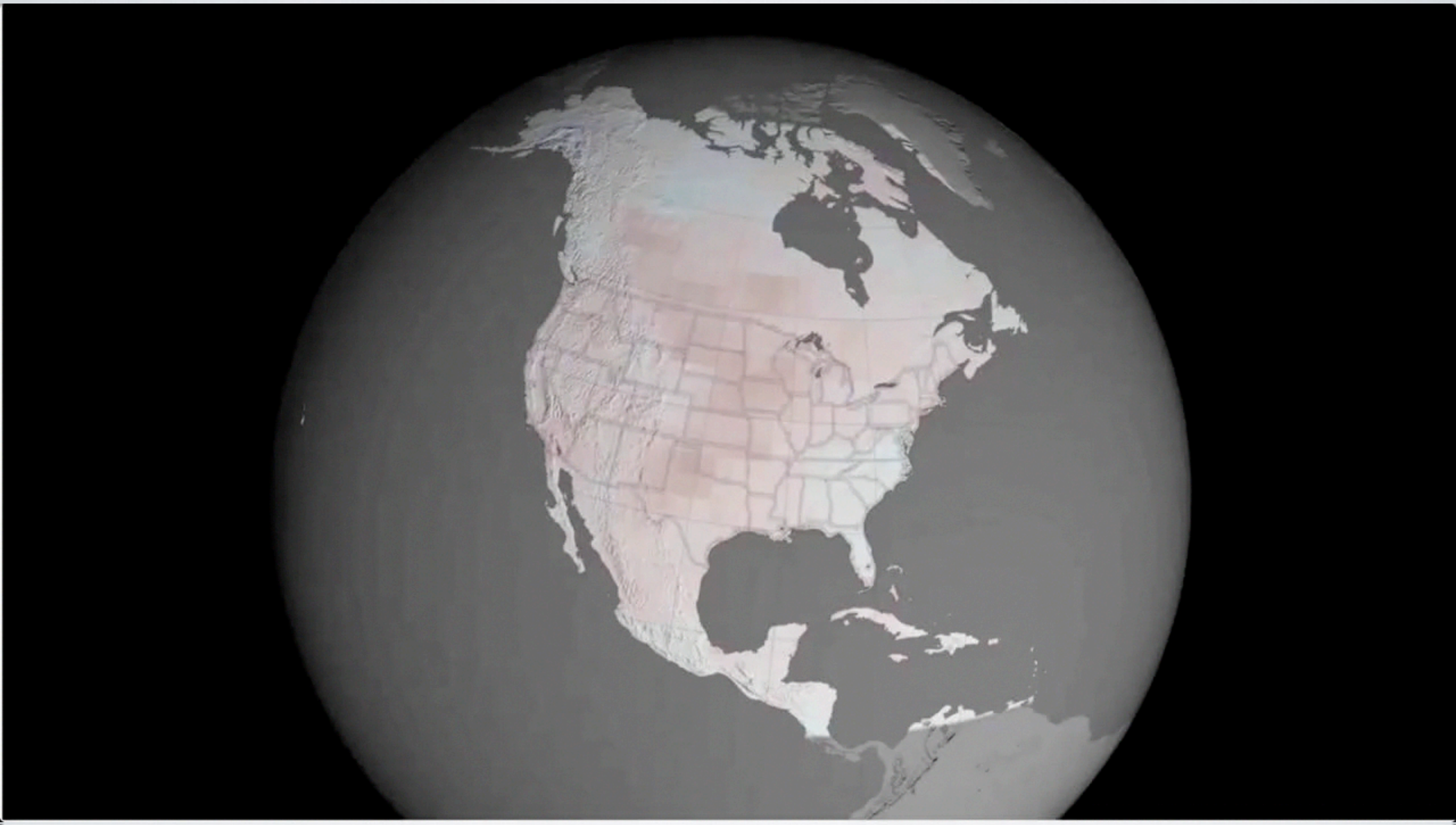


What About Soils?

Projected Soil Moisture Levels Due To Climate Change

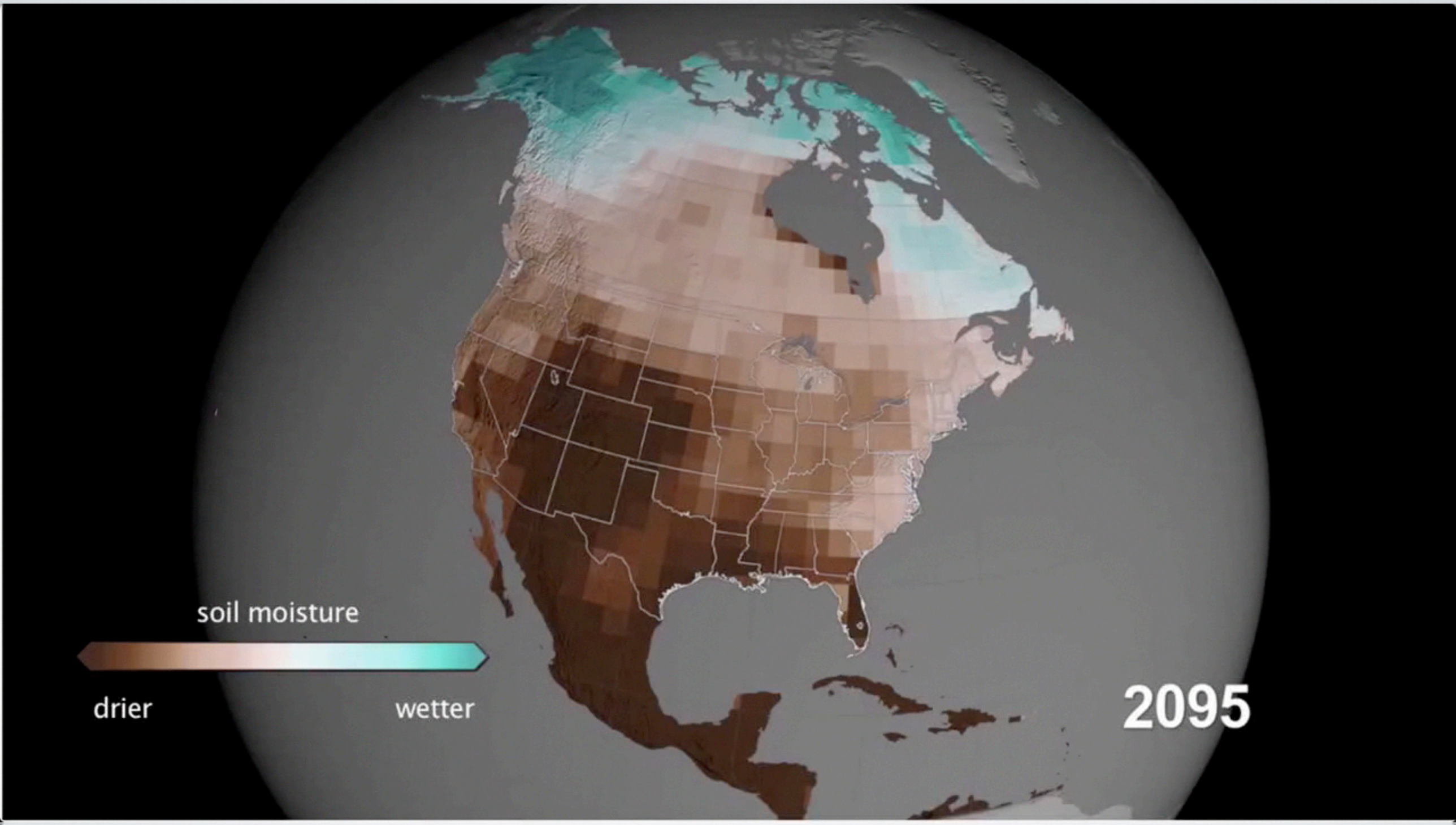
Time Lapse Of Soil Moisture Levels

NASA/GISS Animation High Emission Scenario



Time Lapse Of Soil Moisture Levels

NASA/GISS Animation Low Emission Scenario

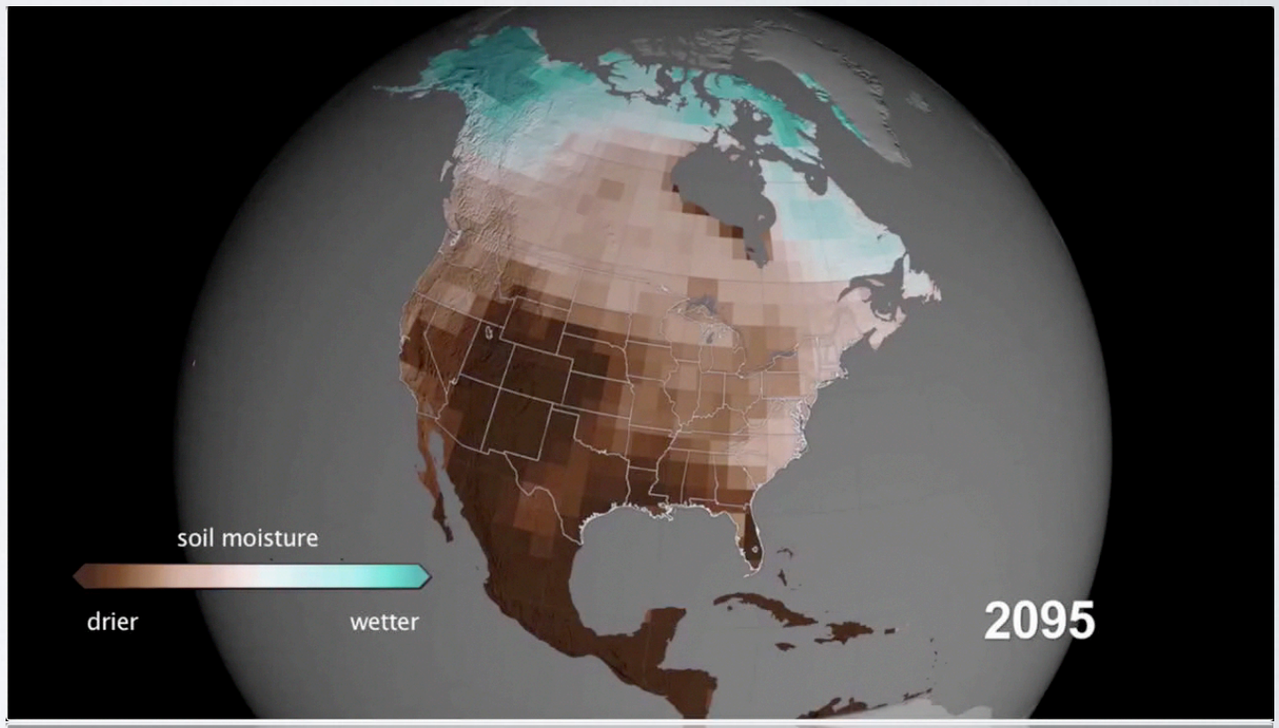


Time Lapse Of Soil Moisture Levels

NASA/GISS Animation High/Low Emission Scenario

High Emission

Low Emission



Questions?

CONTACT INFORMATION

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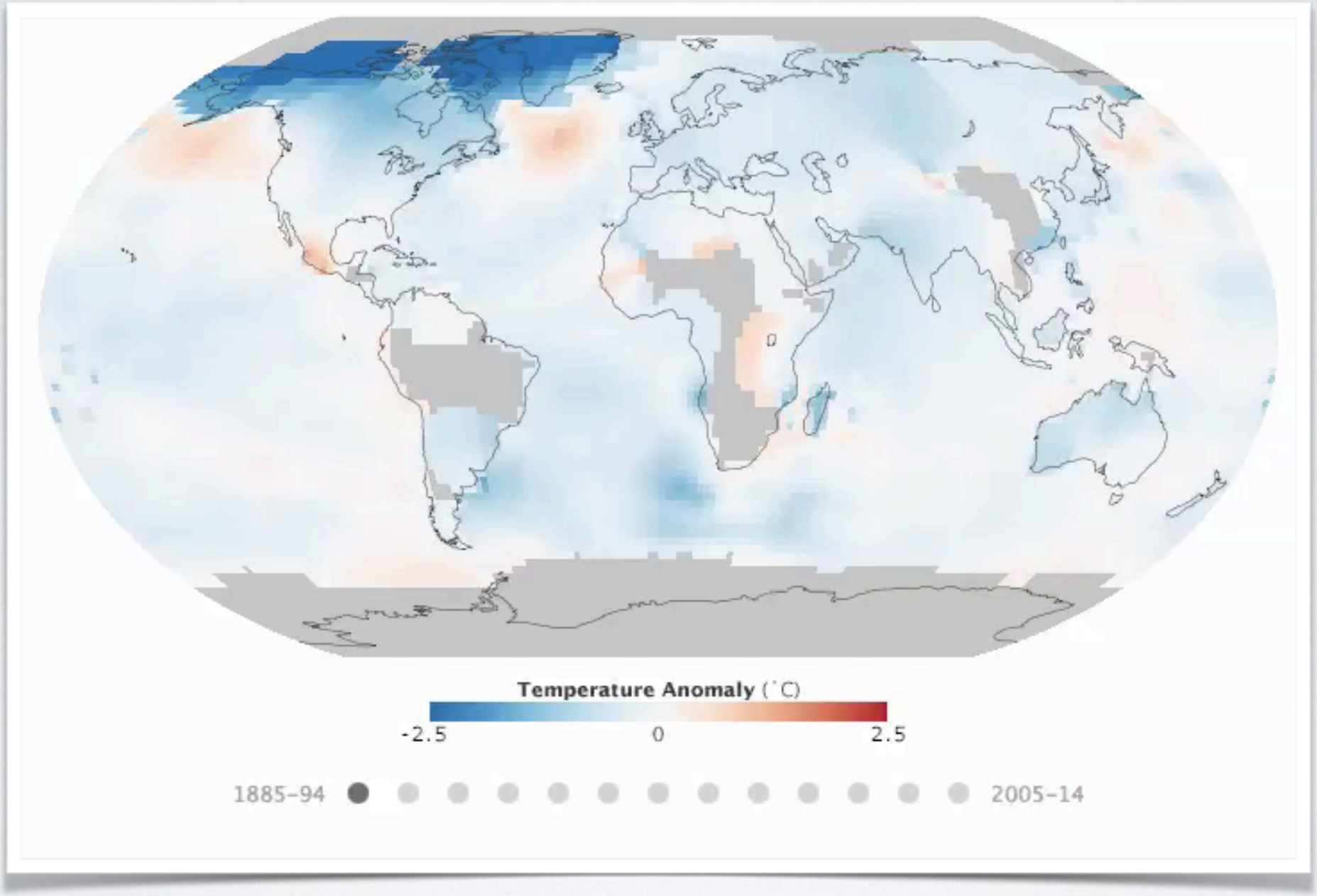
Climate Change Basics

TIME LAPSE OF GLOBAL TEMPERATURE

NASA/GISS ANIMATION



Modeled CO2

NASA/GISS National Lab